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THE
PRINCIPLES AND PRACTICE
OF
SURGERY.

BY

JOHN ASHHURST, Jr., M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF PENNSYLVANIA; SENIOR SURGEON
TO THE CHILDREN'S HOSPITAL; CONSULTING SURGEON TO THE WOMAN'S
HOSPITAL, TO ST. CHRISTOPHER'S HOSPITAL, AND TO
THE HOSPITAL OF THE GOOD SHEPHERD,
ETC.

THIRD EDITION

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WITH

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TO THE

SURGEONS AND STUDENTS OF SURGERY OF AMERICA,

FOR WHOSE USE IT IS DESIGNED,

AND

BY WHOSE FAVOR AND APPROVAL THE LABORS OF ITS PREPARATION

AND REPEATED REVISIONS HAVE BEEN GREATLY LIGHTENED,

This Volume

IS MOST GRATEFULLY DEDICATED

BY THEIR

FRIEND AND FELLOW-STUDENT,

THE AUTHOR.

94388

DEDICATION TO THE FIRST EDITION.

(In Memoriam.)

TO

JOSEPH CARSON, M.D.,

PROFESSOR OF MATERIA MEDICA AND PHARMACY

IN THE

UNIVERSITY OF PENNSYLVANIA,

AS A MARK

BOTH OF RESPECT FOR HIS DISTINGUISHED PROFESSIONAL AND SCIENTIFIC

ACQUIREMENTS, AND OF GRATITUDE FOR MANY PERSONAL KINDNESSES,

This Volume

IS MOST CORDIALLY AND AFFECTIONATELY

INSCRIBED,

BY HIS

FRIEND AND PUPIL,

THE AUTHOR.

PREFACE.

THE object of this work is, as its title indicates, to furnish, in as concise a manner as may be compatible with clearness, a condensed but comprehensive description of the Modes of Practice now generally employed in the treatment of Surgical Affections, with a plain exposition of the Principles upon which those modes of practice are based.

In carrying out this object to the best of his ability, it has been, of course, necessary for the author to have regard to the views of other surgeons, in both this and other countries, and he has not hesitated, therefore, to avail himself freely of the labors both of systematic writers and of those who have illustrated particular departments of surgery by monographs and special treatises. In making use of the work of others, the author has endeavored, in every instance, to give due credit for what he has borrowed, and, should the proper acknowledgment have been in any case unfortunately neglected, hereby begs the reader to believe that the omission has been entirely unintentional.

In revising his work for a third edition, the author has spared no pains to render it worthy of a continuance of the favor with which it has heretofore been received, by incorporating in it an account of the more important recent observations in Surgical Science, and of such novelties in Surgical Practice as have seemed to him to be really improvements; and by making such changes as have been suggested to him by enlarged personal experience as a Clinical Teacher and Hospital Surgeon.

The general arrangement of the volume is the same as in the previous editions; every part has been carefully revised, and, though a considerable amount of new material has been added, yet by judicious typographical changes and by a modification in the arrangement of the Index, so much space has been gained that the number of pages is but slightly increased.

The series of illustrations has been further improved by the introduction of a number of original cuts, chiefly from photographs of patients, and from drawings by the author's friend and former pupil, Dr. J. M. Taylor. In the case of the selected cuts, their original source has been indicated in every instance in which this could be ascertained.

In concluding his work, the author ventures to express a hope that, in its present form, his volume, though necessarily compendious in its mode of dealing with many subjects, may be considered as affording upon the whole a not unsatisfactory representation of Modern Surgery.

2000 West DeLancey Place,
Philadelphia, *August*, 1882.

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ADDENDA.

While these sheets have been passing through the press, and since page 152 was printed, Prof. Lister has, through his assistant, Mr. W. W. Cheyne (Antiseptic Surgery, its Principles, Practice, History, and Results. By W. Watson Cheyne, M.B., F.R.C.S., etc. London, 1882), at last responded to the repeated challenges of other British surgeons, by publishing, in more or less detail, statistics of his practice for the last ten years, together with a very large number of figures, chiefly derived from German sources, showing the results of the Antiseptic Method in the hands of other operators. I have examined Mr. Cheyne's tables with a great deal of interest, but do not find that the results there recorded are better than those which are habitually obtained, in this country at least, by careful surgeons who do not adopt the Antiseptic System. The statistics from German surgeons do not embrace sufficient details to make them of much value for comparison with those of other operators, but they certainly show an improvement over the rather frightful mortality from operations which seems to have formerly prevailed in German hospitals. Whether, however, this improvement is solely due to the adoption of Listerism, cannot, it seems to me, be decided from the facts which have thus far been published.

A twenty-second case of ligation of the innominate artery is to be added to those tabulated on page 571, the operator being Mr. W. Thomson, of the Richmond Hospital, Dublin. The ligature employed was that made from the aorta of the ox, as advised by Mr. Barwell: the patient died from hemorrhage on the forty-second day. Additional cases of *œsophagostomy* have been reported by Mr. Reeves and Mr. Holmes. and one of *œsophagotomy* (for foreign body) by Mr. Spanton. Additional *gastrostomies* have been recorded by several surgeons, including Kni, Fowler (of Brooklyn), Langton, Vincent Jackson, and MacCormac. Tait, Cullingworth, and Eldert have recorded *nephrectomies*, and Fowler (of Bath) a *nephrotomy* for *pyo-nephrosis.* Rydygier is credited (by a writer in the *Gazette Médicale de Paris*) with a second (fatal) case of *extirpation of the pylorus*, and another pyloric gastrectomy (successful) is attributed to Van Kleef, of Belgium. This case, with Tait's and Elder's nephrectomies, and MacCormac's gastrostomy, is to be added to the list of successful operations in abdominal surgery. Holmes's, Spanton's, Langton's, and both the Fowlers' cases are known to have terminated fatally.

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4 to 6 P.M. PHILA. PA.
7 to 8 P.M.

THE PRINCIPLES AND PRACTICE OF SURGERY.

THE word *Surgery*, or *Chirurgery*, as it was formerly written, is derived from the two Greek words χείρ (the hand) and ἔργον (a work). In its earliest and narrowest signification, it was therefore limited to certain manual operations, which we accordingly find that the *surgeon* was formerly in the habit of executing under the direction and guidance of the *physician*, who was considered as occupying a higher grade in the profession, and who took entire charge of, and was responsible for, the management of the constitutional condition of the patient. In the modern application of the term, however, surgery embraces a far wider field; and hence the division adopted in France, into internal and external pathology, is in some respects preferable to that into medicine and surgery, which is habitually used in England and in this country.

The consideration of surgical affections naturally divides itself into the discussion of (1) Surgical Injuries, and (2) Surgical Diseases. These will therefore form the topics of the principal divisions of this work. As, however, the condition known as Inflammation, or the Inflammatory Process, with the corresponding constitutional state designated by the term Inflammatory Fever, are common attendants upon both classes of affections, it will be convenient to consider these before entering upon the two great divisions of the subject; more especially as without definite ideas as to the course and treatment of inflammation, the student can scarcely hope to pursue his further investigations into surgical science with either pleasure or profit.

It will likewise be convenient, in this introductory portion of the work, to consider the subjects of operations in general and the use of anæsthetics, together with the lesser manipulations usually classed as belonging to minor surgery, and the various amputations, which are applicable to so many different lesions and morbid conditions, as to entitle them to be looked upon rather as a part of general than of special surgery.

CHAPTER I.

INFLAMMATION.

INFLAMMATION, or the Inflammatory Process, may be considered from two points of view: the Pathological and the Clinical. In discussing it clinically, its causes, symptoms, course, terminations, and treatment will be successively dwelt upon; but it will be better, in the first place, to examine briefly into what is known of its nature and pathological phenomena.

PATHOLOGY OF INFLAMMATION.

Inflammation was formerly considered as a disease, an entity, a something superadded to the natural condition of the part. This view is now almost universally abandoned, and authors, though differing as to the proper explanation to be given of many of the phenomena of inflammation, are, I think, generally agreed that those phenomena are mere modifications of the phenomena of natural, textural life. These changes, which are always due to the action of an irritant, no matter whence derived, may be observed as affecting the phenomena respectively of function, nutrition, and formation, and in each the changes are primarily in the direction of excess.

Changes of Function.—Thus, as regards *function*, the first effect of an irritant upon muscular fibre is to produce contraction (an increased functional activity), followed by nutritive changes, and, possibly, the formation of new material, pus, etc. Irritation involving a nerve of special sense will similarly be attended in the first place by functional disturbances, flashes of light and photophobia in the case of the optic, and tinnitus aurium and increased sensitiveness to sound in the case of the auditory nerve. The application of an irritant to a secreting gland will, in the same way, cause excessive functional activity, manifested by increased secretion. The increased functional activity may in any case be succeeded by perverted or diminished action.

Changes of Nutrition.—The consideration of the modified phenomena of *nutrition* which are due to inflammation, brings up the question of the share taken by the blood and its containing vessels in the process under discussion. That the quantity of blood in an inflamed part is increased, and that the size of its bloodvessels is greater than in corresponding uninflamed structures, was so patent as to have been the subject of early observation; and hence it is not surprising that, in the absence of more accurate investigations, all the phenomena of inflammation should have been attributed (as was the case for many years) to what was called an "altered activity of the bloodvessels." Modern pathology has, however, shown that nutrition and formation are due to cell-action, and that the office of the bloodvessels is purely that of a servant, to bring new material, and to remove that which is effete and useless.

Hyperæmia.—While, as has been said, the quantity of blood is increased in a part which is inflamed, or in which the inflammatory process is in progress, this increase, or *Hyperæmia*, is not necessarily a part of, nor in any way connected with, inflammation. A simple reference to any of the erectile tissues of the body will suffice to illustrate this point. Again, there may be a true *hyperæmia*, dependent on purely mechanical causes, such as the application of a tight bandage, the pressure of a tumor preventing the return of venous blood from a part, or a diminution of the natural elasticity of the walls of the bloodvessels themselves, not an unfrequent coincidence of the general loss of tone which usually attends advancing age. These forms of hyperæmia, which are always *passive* and due to mechanical causes, are properly designated by the term *Congestion*, which might well be reserved for these conditions; the form of hyperæmia which many writers have called *Active Congestion* being more conveniently distinguished by the name *Fluxion* (a term used by Billroth), or *Determination*.

Determination is essentially an active condition. It is, as we shall hereafter see, clinically speaking, the first stage of Inflammation. A familiar example is the active hyperæmia of the mammary gland which is apt to occur a few days after parturition, and which is sometimes with difficulty prevented from running into absolute inflammation of the part. While determination has been spoken of as an active condition, it is not to be looked upon as a cause of the nutritive and other changes which accompany it in the inflammatory process, but rather as caused by them. As Mr. Simon has well put it, "A part does not inflame because it receives more blood. It receives more blood because it is inflamed."

The vessels of an inflamed part are then enlarged. Whether this enlargement is primary or not, has been doubted. As we have seen that the first effect of an irritant is to increase functional activity, and as *contraction* is the manifestation of functional activity proper to the vessels in a state of health, it would be natural to infer that the primary effect would be contraction. As a matter of observation, it is found that the condition varies according to the nature of the irritant employed, and, as F. Darwin suggests, may depend upon whether the inhibitory or constrictor fibres of the vaso-motor nerves are most affected. When the inflammatory process is established in a part, there can be no question that its vessels are dilated. This fact, as regards the arteries and veins, has been a matter of common observation from the days of Hunter to our own, and as regards the capillaries it has been repeatedly established by the now classical microscopic observations of the web of the frog's foot or bat's wing. Not only are the arteries dilated in inflammation, thus admitting more blood, but they become elongated and tortuous; they have also been observed to become pouched at points, presenting at different parts of their walls aneurismal or fusiform dilatations. The red corpuscles of the blood likewise find their way into vessels which in the uninflamed state were too narrow to admit of their entrance.

More blood is brought to an inflamed part than the same part would receive in health, and more blood is likewise carried *through* it when inflamed than when healthy. This was shown by an experiment of Lawrence, drawing blood from both arms of a patient who had a whitlow on one hand and not on the other. With regard to the immediate cause of the hyperæmia of inflammation, it would appear to be due to an increased attraction exerted by the tissues of the inflamed part upon the blood circulating within its minute vessels. This theory, the germ of which may be found in the writings of Haller, seems more consonant with what is known of the *textural* changes which occur in inflammation than either the now exploded view of an increased activity of the vessels themselves, or the notion of a *vis a tergo* which would make the hyperæmia due to increase of the heart's action, an increase which, as we shall see hereafter, is rather an effect than a cause of the inflammatory process.

Blood changes.—Beside the changes which are observed in the blood-vessels, in the course of inflammation, the blood itself undergoes certain alterations.

The *red corpuscles* adhere together by their flat surfaces, forming aggregations or clusters, and tend to produce the stagnation which is observed in the capillary circulation under the microscope. In the later stages of inflammation, the number of red corpuscles falls considerably below the normal standard.

The *white corpuscles* appear to be increased in number in the blood of an inflamed part. It is, however, doubtful whether this increase be absolute or only relative, the number of red corpuscles, as has been seen, rapidly diminishing as the inflammation continues. The white corpuscles adhere to the sides of the vessels, and thus further increase the tendency to stagnation of the circulating fluid.

The proportion of *fibrin* in the blood is notably increased in inflammation. It is estimated by Andral and Gavarret that its proportion may rise from 2½ in 1000 parts to 10 per 1000. The *albumen* and *salts* of the blood are somewhat reduced in amount, and the proportion of *water* somewhat increased by the inflammatory process.

Owing to the changes in the constitution of the blood in inflammation, its mode of *coagulation* differs from that of blood in the normal state. The *crassamentum* or *clot* forms more slowly than in health, and is smaller and firmer in consistence. The slowness of coagulation and the increased cohesiveness of the red corpuscles allow the separation of the fibrin and white corpuscles to take place before the process of clotting is completed, and this gives rise to the peculiar appearance which is known as the *buffy coat.* This buffy or fibrinous coat is somewhat contracted and elevated at the sides, and depressed in the centre, whence the clot of inflammatory blood is said to be *cupped.*

Other nutritive changes.—The modifications of the phenomena of nutrition due to inflammation are not confined to the blood and bloodvessels. Important changes take place in the parenchymatous tissues, and it is indeed in these that, according to Virchow, the first manifestations of the inflammatory process are to be traced.

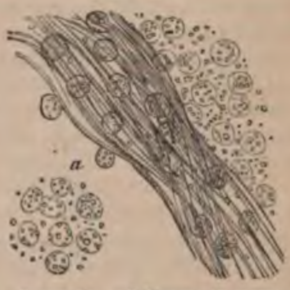
The parenchymatous tissues become *swollen*, the swelling being, according to Virchow, due to the fact that the cells of the part become enlarged, through the absorption of new material; this power of taking up an increased quantity of material is, according to the doctrines of the cellular pathology, inherent in the cells themselves, and not dependent upon any previously established modification in the vascular or nervous state of the part. According to Billroth, however, the first step is a distention and increased pressure in the capillaries, a larger quantity of blood plasma than in the normal state thus passing into the surrounding tissues, the swelling of which is therefore only a secondary phenomenon.

The nervous tissues, likewise, doubtless undergo modification in the inflammatory process, and by a form of reflex action, which it would be foreign to the scope of this work to consider, react in time upon both bloodvessels and parenchyma.

The swelling of the parenchymatous tissue, which is, according to Virchow, at first scarcely distinguishable from a true hypertrophy and which may be conveniently designated as *temporary hypertrophy*, together with the accompanying vascular and nervous changes, correspond to what will be hereafter spoken of as the *first stage of inflammation.*

Formative Changes; *Lymph and Pus.*—The third series of changes to be noticed as due to inflammation, are the *formative*, consisting in the formation of the substances known to surgeons as *lymph* and *pus.* A microscopic examination of inflamed tissue, made at a period varying from a few to twenty-four hours after the commencement of the inflammation, shows the part to be filled with a large number of cells, about $\frac{1}{2500}$ of an inch in diameter, spherical or nearly so, pellucid, and colorless or grayish-white. The origin of these cells, which are commonly called *lymph cells* or *corpuscles*, and which form the corpuscular element of what is known as *inflammatory lymph*, cannot be said to be positively determined. The doctrine which was generally received a few years ago, and which taught that the lymph corpuscles resulted from molecular aggregation, in a substance exuded from the bloodvessels in a fluid condition and subsequently coagulated, is now almost universally abandoned; and the three theories which at present chiefly divide the suffrages of pathologists are, (1) Virchow's, which looks upon the new cellular elements as the result of proliferation[1] of preexisting cells; (2) Cohnheim's, which regards the cells of inflammatory lymph as identical with the white blood corpuscles and cells found in the lymphatic vessels: as identical, in fact, with the *wandering cells*[2] which Recklinghausen has described as existing in connection with the ordinary connective-tissue corpuscles; and (3) Stricker's, which ascribes the new cells to a retrograde metamorphosis of tissue, in which the part returns to the embryonic condition; the basis substance itself, as well as the previously existing cells, thus taking a share in the new production.[3] *Inflammatory lymph*, as ordinarily observed by the surgeon, is a yellowish or grayish-white, semi-solid substance, which is somewhat elastic and semitransparent, resembling a good deal the buffy coat of an inflammatory clot. *Chemically*, it consists of fibrin with an admixture of oily and saline matters,[4] while when examined *microscopically*, it is found to contain fibrils[5] and corpuscles (which have already been referred to), in varying proportion. The *fibrillous*, or as Paget calls it, *fibrinous* element of lymph, is, according to that author, probably exuded from the capillary bloodvessels in a fluid state, and subsequently coagulated; that there is in inflammation an exudation from the capillaries into the surrounding tissue, is, as we have already seen, in accordance with the doctrines of Billroth and

FIG. 1.



Corpuscles and filaments in recent lymph. (BENNETT.)

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[1] It would appear from the observations of Virchow and others, that new may originate from previously existing cells, by one of two processes, viz., (1) *division*, and (2) *endogenous growth*, or the formation of new cells within the cavity of the old. The first process, or that of simple division, is much the more common, and is that to which the term *proliferation* is habitually applied. The first thing observed in this process is the enlargement of the nucleolus, which subsequently becomes constricted in the middle, and finally divides into two. Afterwards the nucleus, and finally the cell itself, undergo similar changes, and thus from one, two or more new cells are developed. The second process, that of endogenous cell-formation, is extremely seldom met with, and indeed the possibility of its occurrence has been doubted by some writers. It is said sometimes to occur normally in cartilage, the supra-renal capsules, the pituitary body (Kölliker), and the thymus gland (Virchow); and has, according to Paget, been met with in certain encephaloid and epitheliomatous tumors.

[2] These cells, in common with many others, possess a power of spontaneous movement which, from its resembling that of the *amœba*, has been called *amœboid* or *amœbaform;* they probably originate in the lymphatic system, from which they pass into the bloodvessels, wandering thence into the surrounding tissue, where they may become fixed, or whence they may wander back again and re-enter the circulation.

[3] According to Stricker, the theory of the migration of cells is based on an illusion; the supposed "wandering" is simply the rapid conversion of basis substance into cells, and the reconversion of cells into basis substance; in other words, it is the *image* seen under the microscope that wanders, and not the cell itself. (Article on Pathology of Inflammation. *International Encyclovædia of Surgery*, vol. i., p. 35.)

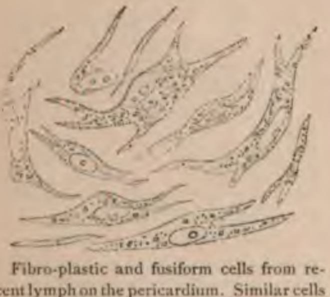
[4] According to Hoppe-Seyler, the lymph corpuscle contains glycogen while its power of movement continues, but upon becoming rigid (transformation into pus cell) loses its glycogen and contains sugar.

[5] Paget speaks of *fibrinous* and *corpuscular* lymph, this division corresponding pretty closely to that of Williams and others into *plastic* and *aplastic*, and to that of Rokitansky into *fibrinous* and *croupous* lymph. Inflammatory lymph is, however, essentially the same under all circumstances, though the relative proportion of its constituents may vary in different cases.

other modern German pathologists; and it is to this exudation that the characteristic succulence of inflamed parts is due. It cannot, however, I think, be considered as established that this exudation takes any direct part in the formation of lymph. According to Billroth, during the active cell-wandering which has been described as taking place in an inflamed part, the filamentary intercellular substance of the connective tissue itself gradually changes to a homogeneous, gelatinous substance.[1] Hence it would appear not improbable that both elements of inflammatory lymph may originate in pre-existing structures, the corpuscular from an increase in the number of wandering cells, from proliferation of the ordinary connective tissue cells, or from both sources, as well as from a return of the basis substance to an embryonic condition, and the fibrillous element also from a transformation of the intercellular substance.

Lymph is said to be *absorbed*, to be *developed* into new tissue, or to undergo various forms of *degeneration*. In some cases where absorption of lymph is supposed to have taken place, it is probable that the true pathological condition has been rather the *temporary hypertrophy* before referred to, due to the nutritive changes introduced by inflammation, without any lymph having been really produced. There can be no doubt, however, that lymph can actually disappear by a process which may be properly called absorption, as is not unfrequently seen in cases of iritis. When lymph is absorbed, the lymph corpuscles may be gradually utilized in the normal nutrition of the part, being converted into ordinary connective-tissue corpuscles, or may possibly resume their migratory habits and re-enter the circulation. In the *development* of lymph into new tissue, it passes through the *fibro-cellular* condition, beyond which, indeed, it frequently does not advance. It is this material which constitutes the adhesions, bands, etc., which are so frequently met with after the inflammatory process has subsided. Lymph that undergoes development becomes vascular; new vessels appear in it, apparently originating from those in the surrounding tissues, and form a capillary net-work through which the circulation is carried on. It is somewhat doubtful as yet whether any production of nerve-fibres takes place in lymph that has become developed into new tissue. The lymph corpuscles during the process of development pass through the forms which have been variously designated as *plastic cells*, *fibro-cells*, *fibro-plastic or caudate cells*, etc. (see Fig. 2).

FIG. 2.



Fibro-plastic and fusiform cells from recent lymph on the pericardium. Similar cells are found in granulations. (BENNETT.)

Lymph may undergo various forms of *degeneration*, as the calcareous, fatty, or granular (the degenerated lymph cells forming the so-called granule or granular cells, inflammatory globules, etc.); it may become the seat of pigmentary deposits, or, when exposed to the air, may form shrivelled and horny masses of effete material.

Finally (a frequent change), *lymph* may be transformed directly into *pus;* the *second stage of inflammation*, that of lymph formation (*lymphization*, *lymphogenesis*), then passing into the *third stage*, or that of pus formation (*pyogenesis*).

Pus is a creamy, whitish-yellow fluid, sometimes having a greenish tinge, thick, opaque, smooth, and slightly glutinous to the touch, with a faint odor and slightly sweetish taste. It is of variable specific gravity, ranging from 1.021 to 1.042, and is neutral or slightly alkaline in its reaction. This description is to be understood as applying to what is called *healthy* or *laudable* pus, derived from an ordinary suppurating wound in a person of good constitution. Beside this form, surgeons speak of *sanious* pus (mixed or tinged with blood), *ichorous* pus (when it is thin and acrid), and *curdy* pus (when it contains cheesy-looking flakes). *Muco-pus* and *sero-pus* are of course pus mixed respectively with mucus and serum. *Chemically*, pus contains water, albumen, pyine (which appears to be almost identical with fibrin), fatty matters, and salts. When formed in connection with diseased bone, pus has been found to contain 2½ per cent. of the granular phosphate of lime, and Mr. Coote, in Holmes's *System of Surgery*, quotes from a paper by Dr. Gibb, of Canada, ten cases in which pus presented a *blue*[1] color from containing the cyanuret of iron. *Orange-colored* pus has been observed by Delore, Broca, Verneuil, and other surgeons.[2]

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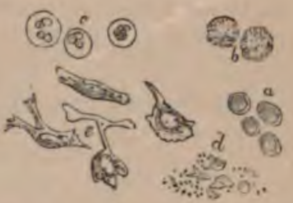
[1] Virchow also refers to this *liquefaction* (as he calls it) of the intercellular substance of connective tissue, as accompanying proliferation. Stricker, as already remarked, maintains that, in inflammation, the entire tissue returns to an embryonic condition.

FIG. 3.



Pus corpuscles. *a*. From a healthily granulating wound. *b*. From an abscess in the areolar tissue. *c*. The same treated with dilute acetic acid. *d*. From a sinus in bone (necrosis). *e*. Migratory pus-corpuscles. (RINDFLEISCH.)

Under the microscope, pus is found to consist of corpuscles floating in a homogeneous liquid (*liquor puris*). These corpuscles, which are variably termed pus corpuscles, pus globules, or pus cells, have a diameter ranging from $\frac{1}{2000}$th to $\frac{1}{3000}$th of an inch. They usually contain several nuclei, which become apparent upon the addition of acetic acid. With these pus corpuscles there are commonly found granular matter, shreds of fibrin, and disintegrated lymph corpuscles. The above description applies to what must be called *dead* pus cells,[3] the *living* cells possessing the power of active amœboid movement, and corresponding in every respect with the *wandering cells* already referred to.

It is even more difficult to speak positively of the origin of the pus cell than of that of the lymph corpuscle. In many cases (as in abscesses) the former seems to originate directly from the latter by a simple liquefaction of the gelatinous intercellular substance of lymph (p. 38); but in other instances the pus cell appears to have a different source.

Virchow and other observers believe that pus corpuscles originate from rapid proliferation (*luxuriation*) of connective-tissue and other nucleated cells, while Cohnheim,[1] on the other hand, maintains that the sole origin of the pus corpuscle is the migration by amœboid movement of the white blood corpuscles through the vascular walls.[2] Prof. Stricker, again, denying the migration of cells, maintains that pus is formed by the return of tissue—basis substance as well as cells—to an embryonic condition, setting free masses of protoplasm, which divide into amœboid cells, these being mingled with granules, shreds from the cell net-work, and portions of tissue *débris* which lose their connection with surrounding parts before the suppurative process is completed, while Schiff declares that pus cells arise by proliferation of the endothelial cells of the vessels of the inflamed part, a catarrhal condition of the lining coats of the vessels thus causing a true suppuration in the blood, before its occurrence in the parenchymatous tissues.

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[1] Billroth and others speak of *blue suppuration*, resulting from the development of small vegetable organisms in the pus of a wound, but the coloring matter (which, according to Sédillot, pertains not to the pus cells but to the liquor puris, and may also be found in the serum of the blood) has been isolated in a crystalline form by Fados, who calls it *pyocyanine;* it is believed by Roucher and Jacquin to be of vegetable origin. Longuet recognizes *three* varieties of blue suppuration, viz., (1) that due to a change in the fluids of the part (*true* blue suppuration); (2) that due to the development of vegetable organisms; and (3) a third variety, which he calls *cyanochrosis*, which he believes to be due to the presence of an unknown substance, and which occurs epidemically, and particularly when the atmosphere is charged with ozone.

[2] The color of *orange pus* is, according to Robin, due to the presence of hematine or crystals of hematoidine; it is often, though not exclusively, met with in pyæmic cases, and is believed by Verneuil to indicate the existence of some grave constitutional condition, such as alcoholism, diabetes, phosphaturia, etc.

[3] The absence of glycogen may, according to Hoppe-Seyler, serve to distinguish the pus cell from the lymph corpuscle. (See note to p. 37.)

Destructive Changes due to Inflammation.—We have now traced inflammation through its nutritive and formative changes, considering in succession the temporary hypertrophy from cellular enlargement, and the development of lymph and of pus, both forms of new material derived from pre-existing elements in the part inflamed. We have next to consider the inflammatory process as affecting already formed tissue in another way, namely, by degeneration or liquefaction. The application of an irritant, such as a blister, excites the inflammatory process, causing the formative changes which have been described, to occur beneath the cuticle. But the cuticle itself undergoes a change, and is thrown off as effete material, leaving a raw surface or *abrasion*. If the irritant act with greater intensity (as in the case of a burn), the destructive effect will be greater, the superficial tissues being thrown off in larger or smaller masses, and an *ulcer* being left. When the process is accomplished by the death of visible particles, it is called *sloughing* or *gangrene*, and the separated parts are called *sloughs;* when the particles thrown off by the destructive action are indistinguishable to the eye, the process is called *ulceration*. Ulceration and gangrene cannot be looked upon as essential parts of the inflammatory process; they are indeed often regarded as terminations or effects of inflammation rather than as themselves parts of the process in question.

Pathological Summary.—Let us now, before entering upon the clinical study of inflammation, briefly recapitulate what has been said as to its pathological phenomena. The inflammatory process, according to the degree of irritation present, modifies the phenomena of natural textural life as regards function, nutrition, and formation: in each case the modification is primarily in the direction of excess. As regards *function*, there is first increased activity, followed by perversion, and eventually, perhaps, by diminution or even total abolition. The *nutritive* changes are shown in an altered state of the vascular system of the part (hyperæmia, determination); in an altered state of the blood itself; in an altered condition of the parenchyma (temporary hypertrophy); and in a change as regards the neurotic condition, which doubtless reacts upon both vessels and parenchyma. The *formative* changes consist in the production of lymph and of pus. There may be also a *destruction* of existing tissue, resulting in its being thrown off as effete material by the processes of ulceration or gangrene.

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[1] Mr. William Addison, more than a third of a century ago, maintained "that pus corpuscles of all kinds are altered colorless blood corpuscles; and that . . . . no new elementary particles are formed by any inflammatory or diseased action." (See his "Experimental Researches," etc., in *Trans. Prov. Med. and Surg. Assoc.*, vol. xi., pp. 247–253.) Dr. Augustus Waller, also, in 1846, described the passage of white blood corpuscles through the walls of the capillaries.

[2] A recent writer, however, Dr. Richard Caton, concludes from observations on the frog, fish, and tadpole, that (1) the migration of white corpuscles is due not to amœbaform movements, but to congestion, as in the case of escape of red corpuscles, and that (2) suppuration may exist without migration ("*auswanderung*") and, on the other hand, migration may exist without suppuration (*Journ. of Anat. and Physiol.*, Nov., 1870). Stricker, as already remarked, believes that the whole theory of migration is based upon an optical illusion.

Clinical View of Inflammation.

In the clinical study of inflammation, there are to be considered successively its causes, its symptoms, its course, its terminations, and its treatment in its various stages and conditions.

Causes.—The *causes* of inflammation may be divided into the *predisposing*, and the *exciting* or *determining* causes. The *predisposing* causes may be said, in general terms, to be any circumstances which impair the general health of an individual, or which render his tissues less capable of resisting the injurious influences to which they may be subjected. Thus the various conditions of a person's life, the nature and amount of food which he consumes, the thermometric and other meteoric conditions to which he is subjected, the nature of his occupation, his having been affected with various diseases at previous periods of life, even his age, temperament, etc., may all be considered at times as causes predisposing to the development of the inflammatory process. The *exciting* or *determining* causes are usually said to be either *local* or *constitutional*, arising either from *without* or from *within.* I think, however, that it is more correct to look upon the determining causes of inflammation as always local or external, those which are commonly considered as acting constitutionally, being really either predisposing causes, or else properly to be termed local, though acting from within the body, and therefore, in that sense of the word, internal.

The determining causes of inflammation are either *mechanical* or *chemical.* Among the mechanical causes are to be enumerated the results of external violence, blows, cuts, wounds of all kinds, fractures and dislocations (in these cases acting from within the body), the presence of foreign bodies, whether introduced from without or originating internally (as a renal calculus), distention of parts, as in the cutaneous inflammation which often accompanies dropsy of the lower extremities, and compression, whether from without or from within. Among the chemical causes may be classed heat and cold, the application of acids or alkalies, poisoning of the blood by septic matters, various forms of contagion, as of gonorrhœa or chancre, etc. Certain forms of nerve lesion may probably be considered determining causes of inflammation. It has long been known that injuries or diseases of nerves may act as predisposing causes, by diminishing the natural power of the tissues to resist the external influences to which they are constantly and unavoidably subjected; thus after spinal injuries, sloughing of the paralyzed parts may be produced by circumstances which would have no perceptible influence in a state of health, and carbuncle, a disease in the progress of which inflammation plays a prominent part, appears to be often associated with diabetes, which there are strong reasons for believing to be, in some cases, an affection of the nervous system. Some experiments, made by Dr. Meissner, would appear to show further that certain nerve fibres exercise a peculiar "trophic" function, and that a lesion of such fibres may be the immediate and determining cause of an inflammatory condition of the parts supplied.[1]

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[1] See upon this point, Holmes's *Syst. of Surgery*, 2d edit., vol. i., pp. 40–41, and Paget's *Surgical Pathology*, 3d edit., p. 36. A clinical observation of Dr. Geo. C. Harlan's, is confirmatory of the same view (*Phila. Med. Times*, Dec. 13, 1873).

It is sometimes said that certain abnormal properties of the circulating blood are to be considered as determining causes of inflammation; but from what has gone before, I think it will appear that this is incorrect. Either a plethoric or an anæmic condition of the blood may indeed act as a predisposing cause, by impairing the general health; or the blood may carry in its course through the system septic or other morbid elements derived either from within or from without, but in this case its function is ministerial merely, and those morbid elements themselves are to be looked upon as the determining causes of the inflammatory process, not the blood, which is simply their vehicle of transmission.

Symptoms.—We have next to consider the *symptoms*[1] of inflammation. These may be distinguished into the *local*, and the *constitutional* or *general* symptoms. The latter will be treated of on a subsequent page, under the heading of *symptomatic* or *inflammatory fever*. The *local* symptoms of inflammation may be classified under six heads, viz.: (1) *alteration of color*, (2) *alteration of size*, (3) *alteration of temperature*, (4) *modification of sensation*, (5) *modification of function*, and (6) *modification of nutrition*. One or more of these symptoms may exist in a part without that part being inflamed, and it is only when they are present in combination, that the diagnosis of the inflammatory process can properly be made. The phenomena of the erectile tissues furnish a familiar example. Again, certain nervous lesions give rise to a combination of these symptoms so striking as to have been considered by many excellent observers to indicate a true inflammatory condition (the so-called *neuro-paralytical* inflammation), and, indeed, this state is one that can be converted into true inflammation by the action of very slight external causes. The degree in which any one of these symptoms is manifested, depends, in a great measure, upon the nature of the tissue in which the inflammatory process is going on. Thus in the case of the skin or of mucous membranes, a change of color is the most prominent symptom. Inflammation of the connective or areolar tissue is particularly distinguished by the swelling by which it is attended. In the fibrous tissues, pain is the best marked symptom. Conjunctivitis or a superficial burn, inflammation of the subcutaneous fascia, and periostitis, may be taken as illustrations of these propositions. Again, modification of function is more prominent in an inflammation involving the eye, than in one affecting a much larger area of the skin or of the alimentary canal, while in some tissues, cartilage for instance, almost the only change that can be recognized after a long duration of the inflammatory process, is an alteration in the nutrition of the part involved.

Redness, the first of the symptoms made classical by the description of Celsus,[2] is perhaps the most noteworthy of all the signs of inflammation. It varies from a bright scarlet, as in the skin, to a deep crimson, or even a dusky, almost purple hue, as in some mucous membranes. In some tissues, other forms of discoloration take the place of redness; thus the inflamed iris becomes gray or brown. The redness of an inflamed part is undoubtedly due to its being in a hyperæmic condition, the capillaries being dilated so as to contain more blood than in the natural state, and the red corpuscles of the blood entering into vessels which, in their normal condition, were too narrow to admit them. In some depressed states of the system, there is an absolute oozing of the coloring matter of the blood through the walls of the capillaries, thus adding a new source of discoloration, while when the inflammatory process has gone on to the formative stage, the new tissue developed from the inflammatory lymph, being very vascular, causes a more or less permanent redness, which, as is well known, may persist in a scar or in a part that has been inflamed for a considerable period.

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[1] Inflammation limited to its first stage (temporary hypertrophy), as is seen in the repair of trivial injuries by immediate union, may be attended with such slight disturbance as to present no recognizable symptoms. Hence immediate union of wounds is said by Paget to be accomplished without inflammation. Clinically speaking, this may be accepted as correct, but if the pathological views given above be true, the *inflammatory process* must exist, though unattended by definite symptoms.

[2] "Notæ vero inflammationis sunt quatuor, rubor, & tumor, cum calore, & dolore, (Celsus, *de re medicâ*, Lib. III., c. 10. Opera, ed. L. Targæ, Lugd.-Bat., 1785, p. 109).

The next symptom that demands our attention is *swelling*. This is of course due in some measure to the hyperæmia of the part, the increased amount of blood in the vessels naturally adding to the common bulk. It is, however, probable that the principal cause of inflammatory swelling, in the first stage, is the increased absorption of nutritive material, this stage of inflammation being indeed, as remarked by Virchow, almost indistinguishable from a true hypertrophy. The swelling may be further increased, if the inflammation continue, by the presence of what are ordinarily called the products of inflammation, viz., by the formation of lymph or pus, or by the exudation of the watery constituents of the blood, or even, in certain cases, of the blood itself. The amount of swelling varies greatly, according to the looseness or closeness of texture of the part affected. Thus the eyelid, when inflamed, swells so rapidly as often to completely close the eye, while inflammation involving the cancellous structure of bone may give rise to the most excruciating suffering, and even run on to suppuration, with almost no swelling in the whole course of the affection. The increase of size of an inflamed part may be evanescent, or may remain as a kind of hypertrophy, as is often seen after the healing of old ulcers of the leg, or still more markedly in the case of bone after long duration of osteitis. On the other hand, from certain nutritive changes to which we shall have occasion to refer again, a part which has been inflamed may become permanently smaller than it was in the natural condition.

The third symptom to be considered is *alteration of temperature, increased heat*. The illustrious John Hunter entertained the view that the increased temperature of an inflamed part was directly and solely due to the fact of its receiving an additional quantity of blood, and hence it is frequently said that the temperature of an inflamed part cannot possibly exceed that of the left ventricle of the heart. The experiments upon this point of Mr. Simon and of Dr. Edmund Montgomery seem to me to establish incontrovertibly the incorrectness of Hunter's view. Their observations, which were made with the aid of a very delicate thermo-electric apparatus, are detailed in Mr. Simon's able article on inflammation in Holmes's *System of Surgery* (2d edit., vol. i., p. 18), and their conclusions seem to me so well established and so important that I do not hesitate to quote them in full. These conclusions are:

"First, that the arterial blood supplied to an inflamed limb is found less warm than the focus of inflammation itself;

"Secondly, that the venous blood returning from an inflamed limb, though found less warm than the focus of inflammation, is found warmer than the arterial blood supplied to the limb; and

"Thirdly, that the venous blood returning from an inflamed limb is found warmer than the corresponding current on the opposite side of the body.

"Unquestionably, therefore, the inflammatory process involves a local production of heat."

That there is thus a *relative* increase of heat due to the inflammatory process may be considered as proved, and that there is an absolute increase over the temperature of the central organs, is, I think, most probable. The sensations of the patient are of course unreliable in determining the amount of increased heat, and, it must be confessed, the impression conveyed to the hand of the surgeon cannot be implicitly trusted. Prof. Gross has, however, by actual observation, repeatedly found the temperature of inflamed parts to be above 100° Fahr., and has, in some instances, seen the mercury in the thermometer rise to 105°, 106°, and even 107°.

The *cause* of the change of temperature in an inflamed part is involved in some obscurity, and, as this question is rather physiological than surgical, I shall not enter upon it further than to say that the chemical processes involved in nutrition may be supposed to cause the normal heat, and therefore when nutrition is disturbed in inflammation, the abnormal heat which accompanies that process; besides which, I see nothing unreasonable in the notion that nervous action may be more or less directly converted into heat —both being now recognized, in the language of the day, as correlative "modes of motion."

The degree of elevation of temperature varies in different instances; it generally becomes less as the inflammation progresses, the thermometer falling to or near the natural standard when suppuration is established. It is scarcely necessary to add that in cases of gangrene the temperature of the dead part falls below the normal standard.

The fourth symptom of the inflammatory process which demands attention is *modification of sensation*, generally manifested as *pain*. The pain of inflammation varies with the nature of the part affected; thus in the mucous membranes it is of a scalding or itching character (as in conjunctivitis or in hemorrhoids), in the serous and synovial tissues it is sharp and lancinating (as in pleurisy or in inflamed joints), in the fibrous tissues it is dull, aching, or boring, and often worse at night (as in inflammation of bone or periosteum). A most distressing burning pain accompanies certain inflammatory lesions of the nervous system. The form of pain varies also with the *stage* of inflammation; thus, on the approach of suppuration, it assumes a marked throbbing or pulsatile character, while a peculiar burning pain sometimes heralds the approach of mortification. The pain is usually most severe when the inflammatory process is at its stage of greatest intensity; but a sudden cessation of the pain of inflammation is always to be dreaded, as often indicating the occurrence of gangrene, as in the case of a strangulated hernia. The pain is usually greatest at the part where inflammation is highest, but this rule has notable exceptions. A whitlow may cause great pain in the axillary glands, while the pain of hepatitis is frequently referred to the right shoulder, and that of hip disease to the knee. The nervous connections of the parts are usually concerned in this misplaced pain, though in some cases (as in whitlow) it is directly referable to irritation transmitted by the lymphatics.

If there is not much pain in any case of inflammation, there is often great tenderness on pressure; as instances may be mentioned cases of inflamed joints, of mammitis, and of swelled testicle.

The *cause* of inflammatory pain is doubtless due, in some measure, to pressure on the nerves of the part due to the inflammatory swelling; but this cannot be admitted to be the sole or even the chief agent in producing the pain of inflammation, for there may be quite as much swelling and nervous compression from congestion or other causes, with comparatively little suffering; at the same time, compression has its effect, for it is found that the pain is usually greatest in those tissues and organs that admit of least external swelling. The principal cause, however, I cannot doubt, of the pain which attends inflammation, is to be found in a direct alteration of the condition of the nerve fibres themselves.

The pain of inflammation sometimes serves a good purpose in warning the patient to guard the affected part from external violence; it is increased or diminished by position and other circumstances which will be referred to again under the head of treatment.

The fifth local symptom of inflammation is *modification of function*. This has been already mentioned in discussing the pathological division of the subject, and I trust that it was then made clear that altered function is an essential part of the inflammatory process. The functional disturbances due to inflammation are perhaps most evident in the case of the organs of special sense; thus deep-seated inflammation of the eyeball is commonly attended by frequent scintillations and flashes of light, at the same time that the power of vision may be impaired or entirely abolished. Again, in the case of an inflamed gland, the function of the organ is invariably affected, not only the amount secreted, but the properties of the secretion itself, being materially different from what they are in the normal condition. A slight degree of irritation, as has been already said, *stimulates* the function of secretion. In absolute inflammation it is temporarily *suspended*, and when *restored*, the nature of the secreted material is usually markedly altered.

The power of using an inflamed organ is much impaired or altogether lost. It is well that this is the case, as, were it possible to read with a seriously inflamed eye, or to walk with a knee affected with acute arthritis, it is evident that the prospects of recovery of the diseased part would often be materially lessened.

Lastly, a prominent symptom of inflammation, and one which is always present, is *modification of nutrition*. In the first place, as has been already seen, there is a positive hypertrophy of the affected part. This may persist after recovery, or the part may resume its natural size, or may even contract and become as it were atrophied. Inflammation may be attended with induration (as in the so-called *phlegmonous* inflammation of the subcutaneous tissues), or it may be attended with softening, as in the case of bone; or there may be a slow wasting from a kind of interstitial absorption, without any softening or production of new material.

Course.—Inflammation is often spoken of as *acute*, *subacute*, and *chronic*. This classification may be, and doubtless is, convenient for certain purposes, but must, I think, be deemed incorrect. The inflammatory process is the same, no matter what duration of time it occupies, and no matter with what intensity its phenomena are displayed. It may, however, be properly regarded as having three principal *stages*, through all of which it frequently passes, though it may be arrested at any period of its course. The *first* stage of inflammation embraces all the phenomena of the process from determination, or simple active hyperæmia, to the temporary hypertrophy which has been so often referred to; the *second* stage is characterized by the appearance of lymph, and the *third* by the occurrence of suppuration. Besides these we may recognize certain subordinate stages, as that of serous *effusion*, that of *ulceration*, and that of *gangrene*. The *effusive* may be considered a modification of the ordinary second stage of inflammation, and is most marked in certain tissues, particularly the serous and synovial membranes. The *ulcerative* and *gangrenous* stages are very closely connected together, the former being met with on the surface of organs merely, while the latter may involve the entire thickness of the part in which it occurs. Many authors describe these, which I have called *stages* of inflammation, as separate *forms* of inflammation; it seems to me, however, that the inflammatory process must be considered as essentially the same under all circumstances; and hence that it is more correct, and equally convenient, to look upon effusion, suppuration, ulceration, etc., as various stages of one process, their occurrence being dependent on extraneous circumstances, such as the nature of the part affected, the intensity of the original irritating cause, or the general state of health of the patient in whom the process is going on, rather than on any essential diversity in the process itself.

First stage.—The symptoms of the *first stage* are those which have already been considered, viz.: changes of color, size, temperature, sensibility, function, and nutrition.

Second stage.—The development of lymph is attended with certain modifications of these symptoms. Thus, the swelling may become harder, or there may be an œdematous condition of the subcutaneous tissue from the concomitant effusion of serum. The period at which the development of lymph (or as Prof. Gross terms it, *lymphization*) occurs, varies with the tissue affected. In inflammation of the serous membranes, as the pleura, arachnoid, or peritoneum, it occurs early; in those of the mucous membranes seldom at all, and when it does occur, at a comparatively late period of the disease.

Third stage.—The approach of the third or suppurative stage of inflammation is usually attended with marked changes. The redness becomes more dusky, and the swelling softens in a certain part of its area, the surrounding tissue being hard and infiltrated from the presence of lymph. The pain becomes pulsatile and throbbing. The cuticle over the softened portion may desquamate. If the part which is about to suppurate be of sufficient size, the presence of fluid beneath the skin may be detected by the touch recognizing *fluctuation* or *undulation*. Under other circumstances, pus may form in large quantities with very little warning, and without the occurrence of the symptoms which have been described. In suppuration of mucous membranes, pus makes its appearance in the natural mucous coating of the part at an early period. The process of *pointing* of pus in the deeper seated tissues will be considered when we come to speak of *abscess*.

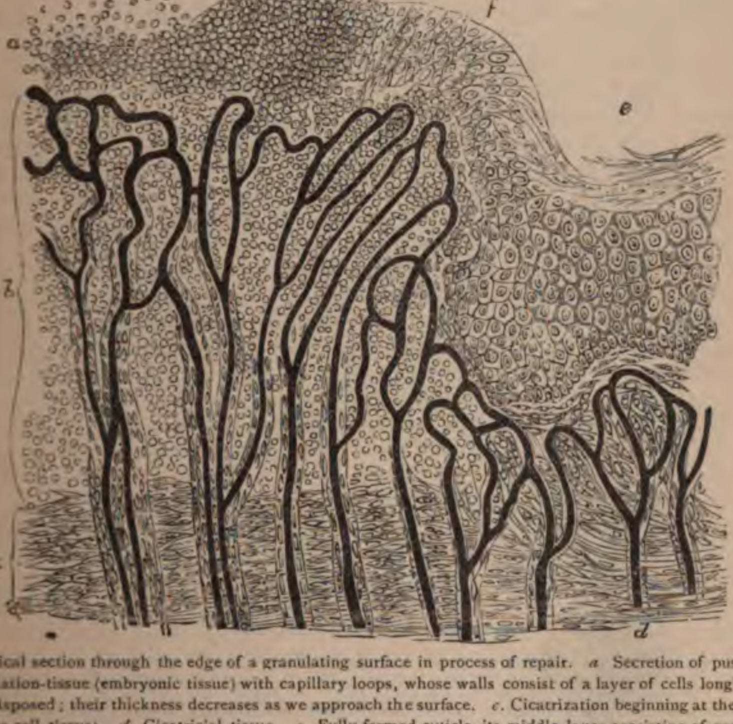
Ulceration.—The *ulcerative* stage of inflammation is that in which, in addition to the nutritive and formative changes that have been considered, there is a destruction of previously existing tissue, which is thrown off by the process of ulceration. Ulceration may be defined as that part of the inflammatory process in which portions of inflamed tissue, degenerate or liquefied, are thrown off in solution or as very minute particles from the surface of the inflamed part. Some writers speak of ulceration with absorption of the degenerated material, and thus consider that the process may occur in the deep-seated tissues of the body. I think, however, with Sir James Paget, that it is better to give this the name of *interstitial absorption*, which has been already referred to as one of the nutritive changes of inflammation, and to restrict the term ulceration to the process as met with on free surfaces, where there is an absolute casting off of the degenerate and effete material.

During the process of ulceration, or while an ulcer is spreading, the affected tissue is surrounded by a circle which is inflamed, and which presents the ordinary symptoms of the inflammatory process. The edges of the ulcer are more or less sharply cut, and often have a jagged or eroded appearance. The destructive action may affect the subcutaneous tissue more than the skin itself, so that the latter may be undermined for a considerable space around the ulcer. The surface of the ulcer itself, during its period of spreading, is covered with a gray or yellowish layer of dead material (a *slough*, in fact), which may be very thin, consisting of mere shreds and patches, or may be thick, soft, pultaceous, and elevated. The discharge is very slight, and more serous or sanious than purulent, though I doubt if there can be any true ulceration without the existence of pus.

When an ulcer ceases to spread, the symptoms of surrounding inflammation subside, and the appearance of the ulcer itself undergoes corresponding changes. Its edges become firm, from the infiltration of lymph, and are frequently hard and elevated. The face of the ulcer becomes clean, and the superincumbent slough comes away in flakes or is apparently dissolved in the discharge, which, though still in very limited amount, approaches more closely to the characters of normal pus.

Granulation and Cicatrization.—The repair of an ulcer is a very interesting process. The ulcer contracts, while its surface becomes elevated above the edges, and presents a vascular appearance, seeming as if studded with numerous papillæ; the discharge becomes more profuse, and presents the characters of healthy or laudable pus, while a faint blue line along the edge of the ulcer marks the gradual advance of the healing process. The papillæ which have been spoken of above are called *granulations*, and an ulcer is said to heal by *granulation* and *cicatrization*. Granulations appear to consist of lymph which has become organized into new tissue, and their peculiar conical shape corresponds with the loops or arches of new vessels[1] which give them their great vascularity. Healthy or normal granulations are small, closely set, of a bright red color, and covered with healthy pus;

FIG. 4.



Vertical section through the edge of a granulating surface in process of repair. *a* Secretion of pus. *b*. Granulation-tissue (embryonic tissue) with capillary loops, whose walls consist of a layer of cells longitudinally disposed; their thickness decreases as we approach the surface. *c*. Cicatrization beginning at the base (spindle-cell tissue). *d*. Cicatricial tissue. *e*. Fully formed cuticle, its middle layer consisting of grooved cells. *f*. Young epithelial cells. *g*. Zone of differentiation. (RINDFLEISCH.)

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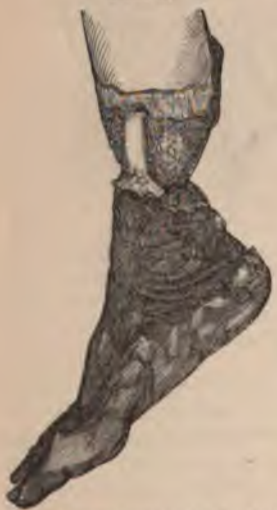
[1] This is denied by Hamilton, of Edinburgh. See foot-note in Chapter vii. (Repair of Wounds).

they may under various circumstances be irritable, and bleed on the slightest touch, or they may be indolent and flabby, œdematous as it were from serous effusion, and may become detached in large masses as if they had not enough vitality to preserve their nutrition.

The process of *cicatrization* does not begin until that of *granulation* is so far advanced that the edges of the ulcer appear depressed as regards its surface, the granulations themselves being healthy and covered with a layer of laudable pus. In the process of cicatrization, the granulations become smooth and flat, and become covered with a thin bluish-white pellicle, which is the new skin. Cicatrization almost always proceeds from the surface to the centre, though occasionally islets of new skin are apparently formed in the middle of an ulcerated surface. Within the faint-blue line of new-formed skin, may be traced a line of deeper red than the ordinary color of the ulcer, consisting of granulation tissue in the transition stage to epithelium. The closure of the ulcer is promoted also by the contraction of the newly-formed tissue, probably owing to the transformation of the lymph or granulation cells into fibrils, which occupy less space, and therefore occasion the shrinking which is characteristic of all cicatricial tissues. In some instances contraction of the ulcer appears to *precede* the development of granulations. The healing of an ulcer leaves a permanent scar, which undergoes various changes subsequent to its formation. Thus the scar of a burn may continue to contract for many months after the process of healing is complete, giving rise in this way to marked and sometimes very distressing deformity; there would appear indeed in some cases to be an actual development of elastic tissue in a scar, so persistent and irresistible is its contractile tendency. A scar when first formed is usually redder than the surrounding skin, or it may be bluish as if deeply congested; in the course of time its color fades, so that an old scar is commonly of a dead-white color. Cicatrices gradually assume the appearances of the surrounding textures, and at the same time their deep attachments become stretched and loose, so that the mobility of the part is after a time measurably restored. A scar, however, never entirely gains the characters of the tissues around it, and is always more susceptible to injury, and more likely to give way and again become the seat of the ulcerative process, than the tissue in its immediate neighborhood which has never been affected. It has been pointed out by Mr. W. Adams that cicatrices formed in childhood *grow* with the part in which they are placed.

FIG. 5.



Complete sphacelus of foot and ankle. The sloping line of separation well shown; studded with granulations. (MILLER.)

Gangrene.—As *abrasion* (see page 40) is like but less than ulceration, so may *gangrene* or *sloughing* be considered ulceration on a larger scale, and the *gangrenous* as closely allied to, and, indeed, but a modification of, the ulcerative stage of inflammation. Where an irritant has acted with great intensity, so large an amount of tissue may be deprived of vitality that *mortification*, *gangrene*, or *sphacelus* is said to have occurred. The term *sphacelus* is sometimes limited to gangrene of the soft tissues; that of the bones is called *necrosis*. A *mortified*, *gangrenous*, or *sphacelated* part of the body can only be removed by the process of granulation, and when isolated by that process is said to be a *slough*, while the part affected is spoken of as *sloughing*.

Gangrene may occur at a late stage of the inflammatory process, or it may be primary, from the intensity with which the original irritant has acted. The onset of gangrene is marked by a peculiar dusky redness of the inflamed tissues, by the formation of bullæ, filled with a dark fluid, and by the part, from being hard and tense, becoming doughy to the touch; the pain becomes burning, and the temperature of the part falls. When mortification has actually occurred, the skin becomes mottled, purple, greenish, or even black; sensibility and motion are lost; the part may seem shrunken; it becomes colder than the surrounding tissue, and a peculiar odor is emitted, due to gaseous exhalations from the gangrenous mass.

This description is to be understood as applying to what is known as *moist gangrene;* there is another form of mortification, resulting principally from arterial obstruction, and to which the name of *mummification* or *dry gangrene* is applied, which presents somewhat different characters, and which will be considered in its proper place.[1]

When the spread of gangrene has been arrested, whether from the irritant which caused it having, as it were, spent its power, or from having reached tissues which have more vitality, and are therefore more capable of resisting the gangrenous process, what is called the *line of demarcation* is formed. This appears as a line of more or less vivid redness (sometimes preceded by a circle of minute vesicles), which immediately surrounds the mortified part. This *line of demarcation* is soon replaced by a line of granulations called the *line of separation*, and the slough is gradually pushed off, as it were, by the formation of new tissue beneath it, a healthy ulcer remaining when the dead part is finally removed. It is usually said that the separation of a slough is effected by ulceration; but, as justly remarked by Mr. Coote, it is rather by the process of granulation; there is no destruction of living tissues beyond the slough, but the spread of the gangrene is immediately succeeded by the reparative process of granulation.

Inflammatory Fever.—We have now considered the local manifestations of the inflammatory process in its ordinary stages, those of determination, lymph development, and suppuration, as well as in its subordinate stages or varieties, those of effusion, ulceration, and mortification. The next subject for discussion is the effect of the inflammatory process on the general condition of the patient, or, in other words, the constitutional symptoms of inflammation, which may be grouped together under the name of *inflammatory, sympathetic*, or *symptomatic fever*. *Traumatic* fever is another name which has been used, but which is objectionable, because the condition signified may accompany inflammation which is entirely independent of traumatic causes. *Surgical* fever would be a good name, but for the confusion which might arise from the term having been applied (by Sir J. Y. Simpson) to an entirely different affection, viz., pyæmia. It is probable that no inflammation, however slight, is altogether unattended with symptomatic fever, though the course of the latter may be so mild as not to excite attention. An ordinary attack of inflammatory fever comes on usually within twenty-four hours of the first development of the inflammatory process. Mr. Pick, of St. George's Hospital, found that in seventy-three cases of inflammatory fever following wounds, the first symptoms were usually manifested about the sec-

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[1] If a part dies quickly, while full of blood and other fluid matters, the gangrene which ensues is of the *moist* variety; when the death is slower, the gangrene is *dry*. The occurrence of moist gangrene is chiefly determined by the existence of venous congestion.

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ond or third day, sometimes later, but never after the fifth day, and occasionally within the first twenty-four hours (*St. George's Hosp. Reports*, vol. iii., p. 74). As the inflammatory process itself usually does not commence until about twenty-four hours after the reception of a wound, it will be observed that this statement corresponds pretty closely with that above given as to the commencement of the symptomatic fever. The onset of the fever may be heralded by various abnormal sensations; there may be an absolute rigor, or merely chilliness, alternating with flushes of heat. The pulse rises in frequency, varying from seventy or eighty to even one hundred or one hundred and twenty beats in the minute. It may be full but compressible, or hard and tense though small, as in cases of peritonitis. The respiration is usually hurried and somewhat oppressed, and there may be evidences of positive congestion of the pulmonary structures. The tongue may be red, dry, and clean, or coated with a white fur; the mouth feels clammy, and the patient suffers from thirst. The bowels are usually confined, and the secretions vitiated. The urine is scanty and high-colored. There may be frequent micturition, or, on the other hand, retention of urine, requiring the use of the catheter. The skin is hot and dry, the temperature having been found to rise as high as 102.5°–103° Fahr. by Dr. Montgomery, 104° by Mr. Croft, 104.6° by Mr. Pick, and 104.5°–105.5° by Prof. Billroth. The face is flushed, the eyes injected, and there may be distressing headache, together with muscular pains and general uneasiness. The patient is apt to be delirious at night. In favorable cases, as the local phenomena of inflammation decline, the violence of the symptomatic fever likewise passes away. The beginning of convalescence may be marked by profuse acid sweating, by diarrhœa, profuse diuresis, or even hemorrhage from the mucous membranes, constituting what the older writers called *critical discharges*.

This is the course of an ordinary attack of inflammatory fever, as seen in healthy persons in connection with traumatic or other inflammations, unattended with special causes of depression. Under other circumstances there may be fever of an *asthenic* or *typhoid* type, resembling a good deal the ordinary forms of enteric fever. In these cases the tongue is covered with a dark-brown fur, and is apt to be dry; sordes accumulate about the lips and teeth; the countenance presents a dusky hue; the pulse is unusually feeble; the patient seems dull and soporose, and the delirium assumes a muttering character. This form of inflammatory fever is often attended with pneumonia of a low type. Convalescence from it is slow and interrupted, and in fatal cases death may be preceded by hiccough, subsultus tendinum, and coma. In what is called the *irritative* form of inflammatory fever, the nervous system is especially implicated. The ordinary, sthenic, inflammatory fever may pass into the asthenic, or the latter may be present from the first. It is somewhat remarkable that the violence of an attack of inflammatory fever seems to bear no relation to the severity of the wound to which it may be due; a compound fracture may cause less constitutional disturbance than a slight flesh wound. There appears, however, to be a general correspondence between the intensity of the local symptoms of inflammation and the severity of the symptomatic fever. An attack of inflammatory fever usually reaches its height in about two days from the time of its commencement. Its whole course occupies from two to six days. If the inflammation be arrested in its first or second stage, the symptomatic fever subsides gradually; the occurrence of suppuration is usually marked by a rapid diminution of constitutional disturbance. Thus a case is given by Mr. Pick, in which, on the evening of the third day after a primary amputation for injury, the temperature was 104.6° Fahr., the pulse 110 and throbbing, the tongue furred, the face flushed, and the wound dry and glazed; the next day the temperature had gone down to 100°, the pulse was 84, soft and compressible, and the wound was discharging healthy pus.

Prof. Billroth has described a "*secondary fever*," which begins on or after the eighth day, and he believes that this may occur without any primary fever having existed. It would appear, however, from the observations of Mr. Pick, that there has in these cases always been a primary attack, though it may have been so slight as easily to elude observation. The primary may run into the secondary fever, the temperature not sinking to the normal standard during the interval; and in any case, if the fever last beyond the eighth day, it is to be considered as secondary. The occurrence of secondary fever, which appears to be due to the absorption of septic material, is always to be looked upon with apprehension, as indicating a grave change in the local or constitutional condition. It may be followed by deep-seated or widespread inflammation of the connective tissues, or may herald the approach of serious surgical diseases, such as erysipelas, hospital gangrene, or pyæmia. Genzmer and Volkmann describe an "aseptic" form of traumatic fever, met with in cases of subcutaneous injury, etc., in which the increase of temperature is the only symptom which can be recognized.

Inflammatory fever, as has been said, usually subsides with the occurrence of suppuration. The formation of pus is, however, often attended with marked perturbations of the nervous system, consisting in repeated and sometimes prolonged rigors, alternating with flushes of heat. In cases where suppuration is unduly prolonged, and the patient in consequence weakened, an irritative type of fever is developed which is called *Hectic*. In this form of fever the pulse is more rapid than in health, small, and compressible; the eyes are abnormally brilliant, and the cheeks flushed. The patient emaciates and becomes very feeble. The symptoms are usually most marked in the evening, when the skin is hot and dry, a condition which is often succeeded in the course of the night by colliquative sweating. The "cold sweat" of hectic often alternates or coexists with profuse diarrhœa, both tending to exhaust the patient. I believe that hectic is never established in cases of suppuration until the pus finds a vent externally: as long as an abscess is unopened, hectic will not occur.

Extension of Inflammation.—Inflammation may *extend* from one part of the body to another by *continuity* or by *contiguity* of structure. An instance of the former mode of extension may be found in the spread of tracheitis to the larynx or to the bronchi; an instance of the latter, in the extension of inflammation from the pleura to the lung, or from the bones of the skull to the membranes of the brain. Extension by *metastasis* is probably rarer than is commonly supposed; the example usually given, viz., the occurrence of epididymitis in the course of gonorrhœa, is, I believe, no metastasis at all, but a simple extension by continuity of structure. Inflammation may spread by means of the *lymphatics*, as in adenitis of the axillary glands following upon a whitlow. The *blood* may indirectly be concerned in the spread of inflammation; as in cases of embolism, where the detatched fragment or clot is carried along in the circulation, and acts as a foreign body. With regard to the agency of the *nervous system* in the spread of inflammation, it is proved that, by a form of reflex action, a part may be rendered more susceptible to the influence of external irritants, and thus predisposed to the occurrence of the inflammatory process; but any more direct agency of the nervous system is still a matter of doubt (see p. 41).

Terminations of Inflammation.—What I have called the *stages* of inflammation are often spoken of as *terminations* of the inflammatory process;

thus it is said to end in the formation of lymph, in suppuration, in ulceration, in gangrene, etc. But I think it will appear from what has been already said, that these cannot strictly be looked upon as terminations, for the reason that in each case the inflammation must go on in the surrounding parts until the whole process of ulceration, of mortification, etc., has been completed. Strictly speaking, inflammation can only end in *resolution* (a gradual return to the healthy state), or in the death of the patient, when of course inflammation must cease with the termination of other vital processes. Even metastasis, which is often called a termination of inflammation, is, as far as the part originally inflamed is concerned, really an instance of resolution. The other so-called terminations do not end the process, but are merely events in its course.

In *resolution* the symptoms of inflammation more or less quickly disappear. The pain and heat diminish, the swelling subsides, and the redness slowly fades away. The function of the part is gradually restored, and its nutrition slowly returns to the normal state. The dilated bloodvessels contract, the stagnant blood corpuscles are pushed on, and absorption, which had been to a great extent suspended, begins again with renewed activity, helping to remove the adventitious, newly formed material. Resolution may be complete, or only partial; in the latter case the part that has been inflamed remains permanently altered in structure. Thus inflammation of the eye may cause permanent opacity of the cornea, and gonorrhœa a troublesome form of urethral stricture.

CHAPTER II.

TREATMENT OF INFLAMMATION.

Before entering upon the subject of the treatment of inflammation, it may be well to reiterate what was said in the opening of the first chapter, that this process is not to be looked upon as a *disease*, to be met with lancet and calomel on the one hand, or with brandy and opium on the other, but is to be viewed as a modification of natural processes, which may often be conducted to a favorable termination by judicious management on the part of the surgeon, or by bad treatment may easily be made to end in destruction of the part affected, if not in the death of the patient.

In dealing with any individual case of inflammation, the surgeon should bear in mind the nature of the pathological changes which are in progress, and administer or withhold his remedies with due regard to both the local and the general condition of his patient.

Prophylactic Treatment.—The first object of the surgeon, in every case, should be, if possible, to *remove the cause of inflammation;* and in many instances, if this, which constitutes the *prophylactic* treatment, can be accomplished, nothing more will be requisite. Thus the extraction of a speck of dust from the eye, or of a splinter of wood from the hand, will often prevent the development of inflammation, or at least allow its subsidence if already present. In any case the removal of the cause (if this can be ascertained) must be first effected, even if the inflammation continue and require further attention: the first step in the cure of cystitis dependent on vesical calculus, is to remove the stone; a strangulated hernia cannot possibly be relieved while the constriction remains.

Curative Treatment.—When the cause of inflammation cannot be detected, or after its removal when that can be effected, what may be called the *curative* treatment comes into play. This may be divided into—I. The *Hygienic* treatment; II. The *Local Remedial* treatment; and III. The *General* or *Constitutional Remedial* treatment.

I. The **Hygienic** treatment of inflammation is first to be considered. It is, I think, often more important than either of the others. *Rest* is frequently all that is necessary in the management of even severe injuries (as in many cases of fracture), and by itself will often suffice to prevent the unavoidable and needful inflammation from passing beyond the stage which is required for the repair of the lesion. No severe inflammation, whether from injury or from disease, can be successfully treated without the enforcement of rest, and even in slight cases it will be of great use in promoting and hastening a satisfactory issue. If an important organ (as the brain or lung) be inflamed, the patient should invariably be confined to bed; the same rule should be adopted for severe inflammations of less vital parts. In many cases *local* rest will be sufficient; thus a patient with an inflamed hand or elbow may walk about with the part supported by a sling, when a similar affection of the foot or knee would necessitate confinement to bed. *Functional* rest of the inflamed part is very important. No one should attempt to read with an inflamed eye, to talk with an inflamed larynx, or to write with an inflamed hand.

Subsidiary to rest is *position:* this is a point which should be carefully attended to in the treatment of inflammation. All the symptoms of inflammation, and especially pain, are aggravated by a dependent position; hence an inflamed leg or arm should be supported on, or even elevated above, the level of the rest of the body. Even in cases which do not require confinement to bed, great comparative ease and comfort may be afforded by supporting the affected part with a suitable splint or sling. An apparent exception is to be noted in cases of inflammation about the head. Every one who has had a headache may know from his own experience that it is relieved by lying down, and it is a mistake to suppose that the impulse or blood to the head is diminished (as in the case of the foot for instance) by elevating the organ; the reason is obvious—the brain must have a certain supply of blood, and if the force of gravity be brought into play by elevating the head, the heart compensates for it by increased rapidity of action; hence in inflammation about the head, the recumbent should be adopted in preference to any other posture.

The *diet* of a patient suffering from inflammation is a matter of great importance. Until within a comparatively recent period, surgeons united in recommending what was called "*absolute diet*" in cases of inflammation, and this was usually pretty much equivalent to no diet at all. As regards this matter, I cannot but think that medicine is more advanced than surgery; very few physicians at the present day, I imagine, try to starve out pneumonias, and I cannot see why the principles which are now almost universally adopted in the management of internal inflammations should not be equally applicable in the case of the external, or of the internal when produced by traumatic causes. Up to a certain point, the inclinations of the patient may be looked upon as a pretty safe guide; no man suffering from a violent inflammation, whether external or internal, has an appetite for heavy meat meals or for stimulating sauces, and it may reasonably be concluded that this is a prompting of nature to avoid such condiments. But we must be cautious not to run into the other extreme. It has been, I think, clearly shown by the researches of modern investigators, that in addition to the waste of tissue which accompanies the inflammatory process, there is a large expenditure of force (as evidenced by the great elevation of temperature),[1] and it is but rational to suppose that this waste and expenditure ought to be compensated for by a supply of easily assimilable food.

As to the results met with in practice, it of course becomes any one surgeon to speak with great modesty and hesitation; I can, however, honestly aver that I have met with better success in the treatment of inflammation upon this plan, than I did when I habitually directed low diet, according to the rules still laid down in many surgical works. I do not doubt but that a patient suddenly attacked with inflammation may subsist for a short time—perhaps a day or two—upon barley-water or water-arrowroot, and probably this meagre diet may be more suitable than the heavy meals which he has been in the habit of consuming; but I believe that he will do better still by taking in small quantities and at frequent intervals some light and easily digestible but nutritious article of food. The diet which I myself am in the habit of ordering for patients suffering from severe inflammation, is milk in quantities varying according to the age of the individual, and at longer or shorter intervals according to the facility with which the process of digestion is accomplished. I have supported adult men for weeks at a time upon milk given by the teacupful (f℥iv) every hour, and I know of no single article of food which is adapted to so great a variety of cases as is this. In the more advanced stages of inflammation, beef-essence and different forms of strong broth may be appropriately made to alternate with milk in the patient's diet. As a general rule, once in two or three hours is often enough to give food in cases of inflammation, though when only small quantities can be taken at a time, the interval of course must be shorter. With regard to the administration of alcoholic stimulants no positive rule can be given. In the early stages of inflammation they are usually not required, and should not be given unless the state of the pulse or other circumstances indicate that they are needed. The onset of *delirium* (unless the brain itself be involved in the inflammation) is almost always an indication for stimulation. The quantity to be given should not commonly exceed four to six fluidounces of brandy or whiskey, or half a pint of wine, in the course of twenty-four hours; I have, however, in the later stages of inflammation (as in some cases of severe burn), occasionally increased the amount to as much as a pint and a half of brandy in twenty-four hours, and am sure that I have saved life by doing so. In many of the milder cases of inflammation, or what clinically might be called chronic inflammation, malt liquors may be advantageously substituted for the stronger forms of stimulant.

Other hygienic measures, which will suggest themselves to the intelligent practitioner, should likewise be adopted. Thus, the room which the patient inhabits should be well ventilated, and well warmed in winter. The patient's skin should be kept in a good condition by bathing, or, when this is not practicable from the severity of the attack, by frequent sponging. The body-linen and bedclothes should be kept clean, and all excreta and other sources of pollution removed as quickly as possible. The patient should not be exposed to a glare of light, nor, on the other hand, should the room be kept so dark as to be gloomy. All sources of annoyance, as from noise, etc., should be removed, and while no fatigue, either mental or bodily, should be permitted, the patient, if the nature of his case allow it, should be entertained by light literature (being read to, in preference to reading himself), or by cheerful conversation.

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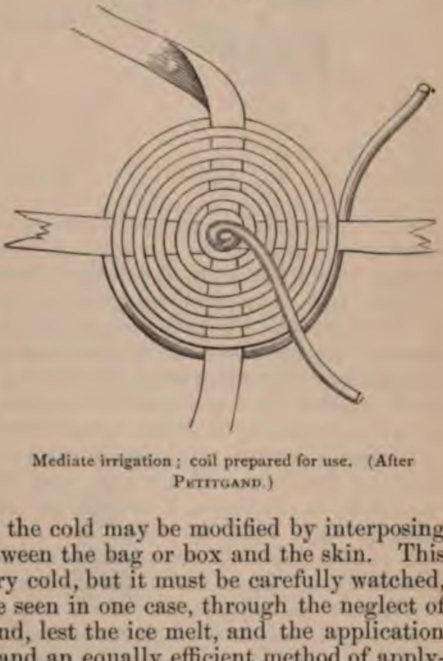
[1] See, in relation to this point, Rev. Dr. Haughton's "Address on the Relation of Food to Work done by the Body," etc. (*Brit. Med. Journ.*, Aug., 1868.)

I have dwelt at some length on these topics, from a conviction that they are too often neglected. The duty of the surgeon is not ended when he has dressed a wound and prescribed a dose of medicine. The hygienic management of a patient is of equal, and, in many cases, of even greater importance, than the mere surgical and medical treatment, which yet, too often, exclusively engrosses the practitioner's care and attention.

II. The **Local Remedial** treatment of inflammation is next to be described. The applications to be considered under this heading may be classified as cold, heat, moisture, local narcotics, stimulants, astringents, antiseptics, counter-irritants, cauterization, local bleeding, incisions, operations, compression, and friction.

1. *Cold.*—There can be no question as to the efficiency of cold as a local remedy for inflammation. It is indeed spoken of, by Mr. Erichsen, as a means of preventing inflammation. Its utility is, perhaps, most obvious in cases of wounds or sprains, though it is likewise of great service in many cases of inflamed joints, and other inflammatory affections not dependent on traumatic causes. It may be applied in the form of dry cold, or in connection with moisture. The use of dry cold has been especially recommended by Esmarch, and is particularly useful where the skin is unbroken, and where it is desirable to avoid the maceration and other discomforts unavoidable with wet applications. Ice may be applied in India-rubber bags of variable shape, or in thin metallic boxes, which Esmarch considers preferable for hospital use. The intensity of the cold may be modified by interposing a folded towel or handkerchief between the bag or box and the skin. This is an admirable way of applying dry cold, but it must be carefully watched, lest it produce gangrene (as I have seen in one case, through the neglect of the attendant), or, on the other hand, lest the ice melt, and the application be no longer a cold one. A safer and an equally efficient method of applying dry cold, is that described by M. Petitgand under the name of *Mediate Irrigation.* This surgeon makes use of a flexible tube of vulcanized India-rubber, sixteen or twenty feet long, and about half an inch thick, the tube-wall being only about a line in thickness. This tube he applies to a limb like a simple spiral bandage, holding it in place by a few turns of a roller, or he makes a coil of the tube, adapting it to the head, to a joint, to the female breast, or to any other part as required, keeping it in position by a few strips of bandage passing alternately above and below the contiguous spiral coils. Through this tube, water is made to flow from a reservoir above the patient's level, of any temperature that may be desired, and by testing the temperature of the water as it leaves the tube, the surgeon can easily ascertain to what degree he has succeeded in reducing the temperature of the inflamed part itself. The application of cold to the head, by this method,

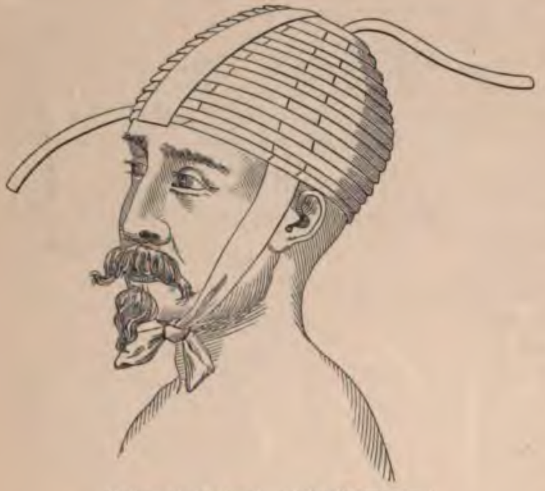
FIG. 6.



Mediate irrigation; coil prepared for use. (After PETITGAND.)

is recommended by Spencer Wells in all cases of traumatic fever, as a means of reducing the temperature of the whole body.

FIG. 7.



Coil applied to head. (After PETITGAND.)

In cases where there is an open wound, the relaxing properties of moisture are often advantageously combined with cold, and here the ordinary form of irrigation by means of a funnel-shaped reservoir with a stopcock, or even a skein of thread or a piece of lamp-wick acting as a siphon, may be conveniently employed. (Fig. 9.) In other cases, simply covering the part with a cloth, which is wetted from time to time with cold water or an evaporating lotion, will be sufficient.

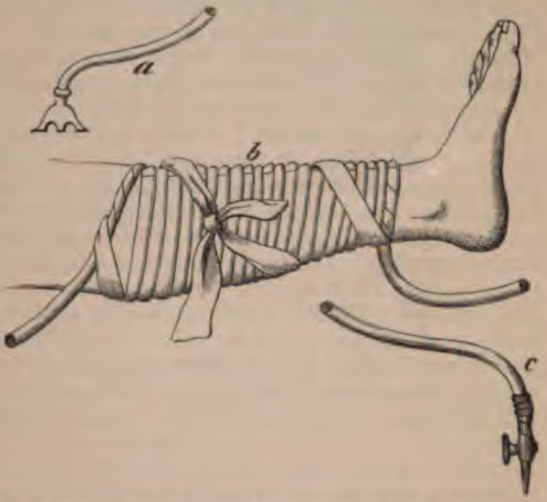
Cold is useful in the early stages of inflammation, when it will greatly assist in promoting resolution, or in the latter stages, when the parts are flabby and relaxed, and when cold, especially in the form of a cold douche, is often extremely useful. Cold is not generally desirable when suppuration is impending, though I have in at least two instances succeeded in causing the absorption of an abscess by the use of dry cold. Cold is rarely useful when suppuration has actually occurred, and should always be avoided in cases of impending or present gangrene.

2. *Heat* is seldom employed in cases of inflammation, except in conjunction with moisture. If dry heat should be desired, it may conveniently be applied by M. Petitgand's method of "mediate irrigation," by merely substituting warm water for cold.

3. *Moisture*, in connection with *warmth*, is a very valuable remedy in inflammation. Heat and moisture may be applied in a variety of ways. *Warm-water dressing* is very useful in cases of suppurating wounds; the water may be applied unmixed, or it may be medicated by the addition of laudanum, lead-water, muriate of ammonium, alcohol, etc. An excellent dressing may be made by diluting alcohol with an equal quantity of water. In applying any form of warm-water dressing, the lint or other material which is saturated with the water should be covered with oiled silk, or with waxed paper, so as to prevent evaporation. Hot *fomentations* are often very useful in the early stages of inflammation: they are commonly directed to be made by dipping flannel in hot water, and applying it to the affected part, renewing it from time to time. This is very apt to cause maceration and desquamation of the cuticle, and hence the application, when repeated several times, becomes extremely painful; to obviate this, I am in the habit of using warm olive oil instead of hot water, a substitution which does not impair the efficiency of the remedy, while it renders it much more agreeable to the patient. Moisture may, in some cases, be advantageously employed by the process of *steaming;* this may be done by means of an ordinary fun-

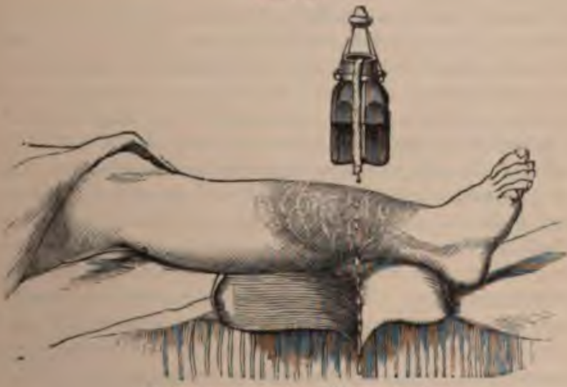
nel, inverted over the hot liquid and directed towards the affected part, or by means of the *atomizer*, now so much used in affections of the throat and air-passages; in employing the latter apparatus, the temperature of the vapor can readily be regulated, by varying the distance of the instrument from the part to which the current is directed. One of the most common, and certainly one of the most efficient, modes of applying heat and moisture, is by means of a *poultice*. I cannot unite in the crusade against this most useful remedy in which some surgeons have engaged: there can be no doubt that poultices have often been abused, and that in certain stages of inflammation they are capable of effecting much harm, but the same objection might be made to lie against any other remedy, and cannot justly detract from their real merit under suitable circumstances. The best materials for making poultices are flaxseed-meal and powdered bark of the *Ulmus fulva*, or slippery elm; in an emergency, however, a very good substitute may be found in corn-meal, or bread crumbs.[1] The poultice should

FIG. 8.



Mediate irrigation: *a*. Supply-tube acting as a siphon; *b*. Coil applied to lower extremity; *c*. Waste-pipe with stopcock. (After PETITGAND.)

FIG. 9.



Irrigating apparatus. (ERICHSEN.)

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[1] Thin sheets of cotton wadding, saturated with a decoction of carrageen, or Irish moss, have been recently recommended as a substitute for poultices by M. Lelièvre, a French pharmaceutist, and have been employed with satisfaction by several surgeons.

be mixed with hot water, and should be of an even consistence, so as to admit of being spread smoothly. Flaxseed or elm poultices should not be more than two or three lines in thickness, and should receive a thin coating of olive oil before being applied; this is to prevent their adhering to the surface of the body, and breaking in removal. Corn-meal or bread poultices must be made about half an inch thick, and may be kept from the surface by the interposition of a piece of thin and soft muslin. Poultices should be made freshly, immediately before application, and should invariably be covered with oiled silk or waxed paper, to prevent evaporation. It is well for the surgeon to give his personal attention to the making and application of poultices, as the patient's comfort greatly depends on the care and neatness with which this is done, and very few nurses will be found to do it properly, unless constantly watched by the medical attendant. The *fermenting poultice*, which is an excellent application to sloughing sores, may be made by mixing wheat or corn flour with half its weight of yeast, and gently warming it until it begins to swell. A convenient substitute is the *porter poultice*, made by incorporating common porter with the ordinary flaxseed poultice. Warmth and moisture, in whatever form used, are especially to be recommended in the second stage of inflammation, and when suppuration is impending. When the discharge of pus is fully established, poultices are as a rule not desirable, while in the gangrenous stage, as already said, a fermenting or porter poultice is often the best application that can be made.

4. The local use of *narcotics* is often advisable in cases of inflammation; thus laudanum may be applied with advantage to inflamed wounds and irritable ulcers, while a belladonna plaster is often of great service as an application to inflamed lymphatic glands. Anodynes may be used in connection with cold (as in the common mixture of Goulard's extract and laudanum), or with heat, as in the form of a *hop poultice*, often employed in cases of peritonitis.

5. *Stimulants* and *astringents* may be used with advantage in the local treatment of inflammation; as instances, I need only refer to the constant employment of nitrate of silver in inflammations of mucous membrane, conjunctivitis, gonorrhœa, etc.

6. *Antiseptics* have lately attracted a great deal of notice in the treatment of inflammation, especially when resulting from wounds. I have myself, for many years, made use of the antiseptic properties of alcohol and of the permanganate of potassium in the local treatment of surgical affections, but the article which is most in vogue at the present time is the carbolic or phenic acid, the merit of introducing which into common use is undoubtedly due to Prof. Lister, of London, though its properties were previously familiar to chemists, and though it had occasionally been employed in surgery, before he directed general attention to the subject. Prof. Lister's mode of applying this antiseptic agent will be described when speaking of the treatment of wounds.

7. *Counter-irritants* are sometimes advantageously employed in the local treatment of inflammation. This is denied by some modern writers of high authority, but, for my own part, I cannot doubt but that great benefit is occasionally derived from the practice. I have seen a bubo disappear without suppuration, under the application of blisters, or tincture of iodine (applied, as advised by Furneaux Jordan, *around*, but not *over*, the inflamed part), and even if this desirable consummation be not attained, the use of the counter-irritant may serve to hasten the formation of pus, and thus shorten the time required for treatment. The advantages derived from the use of sinapisms and turpentine stupes, employed as derivatives, likewise seem to me unquestionable. The principal counter-irritants employed by surgeons are blisters, issues, setons, and moxa.

8. *Cauterization* is a remedy which may prove serviceable in certain cases of inflammation. The actual cautery may be advantageously applied to serpiginous chancroids, while caustic in some form is frequently employed by the surgeon in the treatment of ordinary ulceration.

9. *Local bleeding*, by cupping or leeching, is now much less often resorted to than formerly. The general question of the abstraction of blood in inflammation will be considered under the head of constitutional treatment, but I may say here that I cannot doubt that local bleeding is sometimes of use, and may prevent fatal disorganization in an important organ; I firmly believe that I have seen it do good in cases of traumatic peritonitis.

10. *Incisions*, to relieve tension, are often of great use in cases of inflammation; after incising the tunica albuginea in cases of swelled testicle, I have observed the pain to disappear almost instantly, and the duration of the affection to be very materially shortened. In diffuse inflammation of the subcutaneous areolar tissue, and in phlegmonous erysipelas, numerous incisions are often absolutely essential to check the spread of the morbid process, or even to save life.

11. *Surgical operations* of more or less gravity are frequently required in the treatment of inflammation. Sequestra must be extracted, and gangrenous parts cut away before the attending inflammation can be expected to subside. In this place I may refer to an old suggestion which has been recently revived, to treat or to attempt to prevent inflammation of joints by ligating the main artery of the limb above the part affected. If inflammation were solely dependent upon the condition of the blood and bloodvessels, this might seem reasonable enough; but when we consider that the function of the vessels in inflammation is merely ministerial, and that the increased quantity of blood in an inflamed part is not the cause of, but is itself caused by, the inflammation (see page 35), it will appear, I think, that this plan of treatment is as incorrect in theory as it is in fact dangerous in practice.

12. *Compression* is often of great use in the treatment of inflammation. It is especially in the later stages, when the parts are left flabby and relaxed (as in indolent ulcers), that pressure is of service, though it is occasionally useful at a much earlier period. I know of no better treatment for carbuncle than methodical pressure by the concentric application of strips of adhesive plaster.

13. Finally, *friction* is frequently a valuable remedy in cases of inflammation. The French have systematized the use of friction, under the name of *massage*, to a much greater extent than has been done in England or in this country. Slow and gentle rubbing with warm olive oil, or even with the hand alone, is often very soothing in the early stage of inflammation, and may be of positive benefit in assisting to promote resolution: I have found it of great use in the treatment of mammitis, and it may also be employed in cases of sprains; in the later stages of inflammation, again, friction may prove a valuable adjunct to the employment of the cold douche.

III. **Constitutional Treatment.**—We have next to consider the *General or Constitutional Remedial* treatment, which, except in very slight cases, is not less important than the local measures adopted.

Depletion.—Until within a comparatively recent period, any surgeon being asked what was the most important remedy in the treatment of inflammation, would have answered unhesitatingly that it was *bleeding;* and the expression was constantly used that venesection was the surgeon's "sheet-anchor" in dealing with inflammatory affections. Now I suppose that there is no fact better established in the whole circle of therapeutic observation, than that certain of the symptoms of inflammation (especially pain) can be relieved by the abstraction of blood; and hence, when the prevailing doctrines of pathology taught that the essence of inflammation was an altered action of the vessels, accompanied by a morbid richness or "inflammatory" state of the blood itself, we cannot wonder that our predecessors thought that reason and experience united in showing that loss of blood was the surest way of curing inflammation. More careful observation, and more just views of pathology, have, however, now shown that, in the words of Mr. Simon, already quoted, "A part does not inflame because it receives more blood. It receives more blood because it is inflamed." Hence, bleeding does not remove a cause of inflammation; it merely obviates one effect of the inflammatory process. Here, as in the matter of diet, the practice of physicians has, it must be confessed, been more enlightened than that of surgeons. Few would indeed, at the present day, bleed for the inflammation attending a compound fracture, but it is still taught in many of our surgical text-books that venesection is absolutely required in the treatment of injuries of the head, and of wounds of the chest. Now it seems to me but reasonable that we should adopt the same principles in the management of traumatic inflammations that we do in dealing with those of idiopathic origin, and hence, that venesection should not be resorted to in the treatment of surgical affections, except for its immediate mechanical effect in relieving a vital part, the functional or structural integrity of which is in imminent danger. For example, bleeding may be necessary in a case of traumatic as in a case of ordinary apoplexy, when the darkly congested face, turgid lips, distended veins, and laboring pulse give warning that the brain is oppressed, and, unless speedily relieved, will cease to act; or when a wound of the lung is followed by great dyspnœa, pain, and oppression, the loss of a little blood may be of benefit, just as it would at the outset of an ordinary pneumonia presenting similar conditions. Even under these circumstances, I believe local bleeding, by cupping or leeching, will be usually better than venesection; and it should always be considered that the loss of blood is an evil, which may indeed be preferable to a greater evil, but is never a positive good. The experience of any individual surgeon should of course be referred to with great modesty, but I may say that, in twenty years of hospital practice, I have never had occasion to employ venesection, and have directed local bleeding in but very few cases. If general bleeding be ever resorted to, it should be done in such a way as to produce the greatest effect with the least loss of blood; hence the patient should be in a sitting posture, and the blood drawn in a full stream from a free opening in a large vein, generally the median-cephalic.

Arterial sedatives are often useful in the treatment of inflammation, either after the abstraction of blood or as a substitute for it. I am sure that I have derived advantage from the *Veratrum viride* in cases of traumatic peritonitis, given in the form of the tincture in doses of three or four drops every three hours. It is a powerful remedy, and its use should be stopped, or at least suspended, when a decided impression is made in reducing the frequency of the pulse. *Aconite* has been similarly used with advantage. The preparations of *antimony* are often of use in the management of inflammation. They are best adapted to the first stage, and seem to have a decided effect in preventing the further progress of the inflammatory process. This property of antimony has been called the "anticipatory antiplastic" effect of the remedy. Tartar emetic, which is perhaps the best form in which the drug can be given, may be employed in doses of one-sixteenth to one-twelfth of a grain, repeated every two or three hours. It may be conveniently combined with opium and diaphoretics. In any form, antimony is a remedy which should be used with great caution and watchfulness. It should never be given for a trivial inflammation, and should be avoided in cases of children or old persons, or in patients of feeble constitution.

Purgatives have been much employed in the treatment of inflammation. As there is very often a loaded state of the bowels at the beginning of the inflammatory process, a brisk cathartic may be of service, and will often act in some degree as a derivative, thus being additionally beneficial. I usually, however, prefer those purgatives which are milder in their action, such as rhubarb, colocynth, etc. If the tongue be much furred, as is often the case, a blue pill, followed in twelve hours by a dose of castor-oil, will often answer as well as any other prescription. The bowels should not be allowed to become constipated during the progress of an inflammation, but should be relieved from time to time by the aid of enemata, or of small doses of magnesia, rhubarb, or other laxative. There can be no necessity, however, for violent purgation, especially as the articles of food usually given in inflammation produce comparatively little fecal matter.

Diaphoretics and *Diuretics* are of undoubted utility in cases of inflammation. They promote secretion, diminish the violence of the attending inflammatory fever, and perhaps act in some degree as derivatives as well. The spirit of nitrous ether may be used as a diuretic, in combination with the neutral mixture or the solution of acetate of ammonia. Digitalis also may be used in the same way.

Opium is an invaluable remedy in the treatment of inflammation. It is a direct promoter of what we have seen to be an important condition of recovery, viz., physiological and functional rest.[1] Of all single remedies it is probably the most useful. It may be given in the form of Dover's powder, or in a diaphoretic mixture. Some such combination as the following will be found well adapted to a great many cases:

℞. Morphiæ acetatis gr. j; Spirit. ætheris nitrosi fʒij; Sacchari albi ʒij; Aquæ camphoræ f℥iijss; Liq. ammonii acetatis f℥iv. M.

℞. Morphiæ acetatis gr. j; Spirit ætheris nitrosi fʒij; Syrupi acaciæ fʒvj; Aquæ aurantii florum f℥iij; Mist. potassii citratis f℥iv. M.

A tablespoonful of either of these mixtures may be given every two or three hours, during the height of the inflammatory fever, and either will be found to unite very satisfactorily the properties of an anodyne, febrifuge, and antispasmodic.

Alteratives.—Certain substances which are usually classed together as *alteratives* have an undoubted efficacy in many cases of inflammation. *Mercury* is much less often prescribed now than formerly, and there can, I think, be no question that our ancestors used it too frequently, and in too large doses. Still I cannot but believe that it does exercise an influence, particularly over the second stage of inflammation, or that attended with the production of lymph. It is, however, like blood-letting and antimony, a dangerous remedy, and a positive evil, though it may on occasion do good. It should, I think, be reserved for cases in which an important organ is endangered, and should even then be used with great caution and reserve. It is especially adapted for inflammation of fibrous and serous membranes, such as the meninges and the peritoneum. It should be given in small doses, as one-sixth to one-quarter of a grain of calomel, or half a grain of blue mass, and may be conveniently combined with opium and ipecacuanha.

Iodide of potassium is a valuable remedy in certain forms of inflammation, especially of the fibrous tissues, such as bone or periosteum. The usual dose is from five to ten grains, three times a day.

Sarsaparilla was formerly much used as a remedy for inflammation, and even now is highly recommended by so eminent an authority as Mr. Erichsen. I cannot say that I have ever seen any effect, good or bad, from the use of this drug, and look upon it as almost, if not quite, inert. In the form of the compound syrup, it may, however, be used as an elegant menstruum for the exhibition of the iodide of potassium.

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[1] The action of opium in inflammation is physiologically explained by its property of arresting osmosis and cell-hypertrophy.

Tonics are of great use, particularly in the later stages of inflammation. Among the best are *cod-liver oil*, *iron*,[1] *quinia*, and the various preparations of Peruvian bark. They are almost always required to support the system under the exhausting influences of profuse suppuration or the occurrence of gangrene.

The mode of treatment which I have endeavored to indicate as suitable in cases of surgical inflammation, is essentially similar to that which has been called the "restorative" in cases of pneumonia, etc. It may be necessary in any case to bleed, to give antimony or mercury, to make free incisions (entailing additional loss of blood), and to resort to other depressing modes of treatment; but, hand in hand with these measures, which, though for the time needful, are all in themselves evils, the surgeon must bring his restoratives as well; he must supply abundance of food, easily assimilable but nutritious, and must in many cases pour in alcoholic stimulus besides, even at the very time when he is applying leeches and administering purges. Finally, in many chronic inflammatory conditions, the surgeon must give up treating the disease, and devote himself to improving the state of the patient's general health; when it will often be found that, the constitutional condition having been amended, the inflammation itself will have spontaneously disappeared.

CHAPTER III.

OPERATIONS IN GENERAL; ANÆSTHETICS.

In its widest sense, a surgical operation may be considered as embracing every manipulation which forms part of the surgeon's practice, from the application of a poultice or the introduction of a catheter, to the extraction of cataract or amputation at the hip-joint; and as the surgeon will have occasion to do many slight and trivial operations in proportion to the number of those which are more important, it is well for him to cultivate a habit of neatness and accuracy in matters which though apparently trifling in themselves, are yet very influential in determining the comfort or discomfort of his patient.

Qualifications of the Surgeon.—Every surgeon should aim to be, if not a brilliant, at least a neat and successful operator; and yet the mere use of the knife and other instruments constitutes but a small part of the operative surgeon's duty. It is of much greater importance for him to be a careful and accurate diagnostician, and to have that knowledge of pathology and therapeutics which will enable him to decide whether an operation should or should not be performed, and, when the operation is over, to conduct the after-treatment of the patient in a judicious manner, than merely to be able to do the operation in a given number of seconds, or to shape his incisions in peculiarly graceful curves; in other words, what is technically called *judgment*, is more essential to a surgeon than mere operative skill. The day is happily past when it was thought right for a surgeon to be a mere handworker under the direction of another, and it is becoming more and more established as a rule, that no one is justified in operating in any case, unless his own practical knowledge and judgment tell him that in that case the operation should indeed be performed. No one can hope to be a successful operator who is not thoroughly grounded in anatomy; it is rather mortifying, after amputating a thigh, to be unable to find the femoral artery without loosening the tourniquet, or to dissect around the neck of the scapula in an attempt to cut into the shoulder-joint; yet the surgeon must not, in his zeal for the cultivation of anatomy, neglect the other branches of medical science. The importance, and even necessity, of a thorough knowledge of practical anatomy, can, indeed, scarcely be overrated; yet it is more essential for the surgeon to be well versed in pathology and therapeutics (or, in other words, to be an accomplished physician), than it is for him to know the attachments of every muscle in the body, or all the possible variations of arterial distribution.

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[1] The muriated tincture of iron may be conveniently combined with the solution of acetate of ammonium, and in this form may sometimes be given with advantage even in the earliest stages of inflammation.

Circumstances Affecting Results of Operations.—The success of an operation does not, however, by any means, depend altogether upon the skill of the surgeon. Every one must know, from his own experience, that during certain periods, or in certain classes of patients, the gravest operations have been followed by favorable results, while among a different set of patients, or at other times, death has seemed almost inevitably to follow even the slightest use of the knife. Various circumstances influence the results of operations.

Age.—The *age* of a patient is a very important point for consideration; children, beyond the earliest period of infancy, as a rule, bear operations well. This is doubtless owing, in some degree, to their freedom from constitutional diseases and from those depressing habits of life which are often acquired with approaching maturity, but is probably also due, in great measure, to the happy carelessness and freedom from anxiety which is characteristic of childhood. A child neither looks forward to an operation with dread, nor is oppressed with care for the future, when the operation is over. While an operation may and often must be performed without regard to the age of the patient, the surgeon should, as much as possible, avoid either extreme of life. The new-born infant has less power of recuperation than the older child, while, on the other hand, an operation might be perfectly proper and suitable if performed on a strong and vigorous man in the prime of life, which would be little better than butchery if practised on one tottering on the verge of the grave. Especially as regards what are sometimes called operations of *election* or of *complaisance*, is the age of the patient to be considered; in a young and healthy woman whose beauty is marred by the contracted cicatrix of a burn, it might be not only permissible, but even imperative, for the surgeon to resort to a plastic operation for her relief, though perhaps that operation might entail long confinement, and might even seriously endanger life; but to practise such an operation on a withered crone, who could at best hope for but a few months or years of existence, would be supremely ridiculous, were it not absolutely improper.

The *general state of a patient's health* exercises an important influence upon the success of an operation. Hence it is observed that those whose occupation has been of an exhausting or otherwise unhealthy character, bear operations worse than those whose lives have been spent under more favorable circumstances. This is one reason why serious operations, such as amputations, are less successful among the inmates of our large city hospitals (for their patients are usually derived from the least healthy class of inhabitants), than among hearty agriculturists who bring to the operating-table a constitution unimpaired by either the diseases or the vices of city life. Hence, too, if, before a battle, soldiers have been worn down by long marches and insufficient food, they will bear the operations which may be rendered needful by the conflict of the day, worse than if their general condition had been unimpaired by antecedent suffering.

The *condition of particular organs* should be carefully inquired into in estimating the chances of success after any operation. No one would think of operating, unless for absolute necessity, upon a patient whose lung contained a large tuberculous cavity, or who suffered from serious organic disease of the heart. Our army medical officers can testify to the unfavorable influence upon the results of operations exercised by the chronic diarrhœa and attendant ulceration of the bowels, from which so many of our soldiers perished during the late war, and every practical surgeon knows how slight are the chances of success, after even a comparatively slight operation, in a patient suffering from affections of the urinary organs, and especially from the chronic forms of Bright's disease. The condition of *pregnancy* may be considered a contraindication to any operation which can be properly postponed until after confinement.

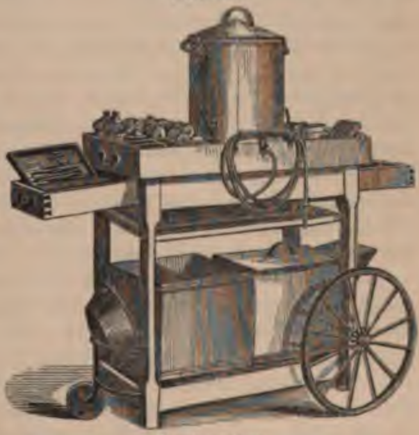
The *temperament* and *idiosyncrasy* of a patient exercise an influence upon the success of operations. Some races, as the Chinese, the individuals of which appear to be of a lymphatic temperament, seem to tolerate operations which among other nations would be extremely fatal. An individual of a cheerful, light, and buoyant disposition, has, I think, a better chance of recovery from a given operation than either one who is gloomy and who fears the approach of death, or one who calmly and philosophically makes up his mind to either alternative.

The *hygienic conditions* to which a patient is subjected before, at the time of, and after an operation, exercise a marked influence upon the success or failure of the operation. A man who is half starved is in no condition to undergo a serious operation, nor, on the other hand, is one who habitually overtaxes his digestive powers by too much indulgence in rich and stimulating food, or who exhausts his nervous system by intoxication. Those who have long been exposed to a close and impure atmosphere, or who have constantly inhaled noxious exhalations, whether of animal or vegetable origin, are less able to undergo an operation than those who have lived in large and well-ventilated apartments and in a healthy locality. The hygienic surroundings of the patient at the time of operation are also of great importance. Except in case of necessity, no operation should be done in very hot weather or during the prevalence of an epidemic, especially of such diseases as erysipelas or hospital gangrene. The room in which an operation is done should be large, well ventilated, and, in cold weather, well warmed; it should be kept scrupulously clean. The army surgeon must, indeed, practise his art in cold and rain, or under the full rays of the summer sun; his operations are eminently those of necessity, and must be done under circumstances which he cannot control. But in civil hospitals, and in most instances in private practice, the operator can secure such surroundings as are needful for his patient's welfare. In certain operations, as in those which involve extensive exposure of the abdominal cavity, these external conditions are of extreme importance; I should not consider any man justified in performing ovariotomy in a cold, a damp, or a foul room.

After an operation, a patient should be placed in the best possible hygienic conditions. As every operation (except, perhaps, the very slightest) is followed necessarily by inflammation, what has already been described as the hygienic treatment of the inflammatory process should be immediately adopted. While the digestive powers should not be burdened by the administration of heavy or irritating food, the patient must not be starved, under the impression that such a course can prevent the development of inflammation. I know of no food better adapted to the condition of a patient immediately after an operation than milk, and hence I commonly direct milk diet under such circumstances. If it seem to oppress the stomach, or if there be any tendency to vomiting, the milk may be diluted with one-fourth or one-third its bulk of lime-water. The after-treatment of a patient who has submitted to an operation should be conducted in a clean and well-ventilated room, sufficiently large to allow from 1500 to 2000 cubic feet of space for each bed which it may contain. In estimating the cubic capacity of a room, it is unfair to consider great height as compensating for limited dimensions in other respects; and the surgeon should not allow beds to be crowded close together, because a very lofty ceiling brings the cubic capacity of the apartment up to the standard. Too much stress cannot be laid upon the importance of free ventilation for a surgical ward; one of the greatest merits of the pavilion system of hospital construction, which was so largely adopted during the late war, was the almost impossibility of making pavilions, especially with ridge ventilation, close, as they would invariably have been, had the patients and hospital attendants found it practicable to make them so. There is room for scepticism as to the practical utility of many of the plans for artificial ventilation which have been proposed of late years; it may be doubted whether anything can compensate for the absence of large windows upon both sides of a ward. While the surgeon would of course not wish to expose his patient to a draught, and would therefore take care not to place a bed immediately beneath an open window, yet it is always better to run the risk of having too much than by any chance to have too little fresh air.

Not only should over-crowding be avoided in a hospital ward, but the surgeon should adopt means to avoid all sources of zymotic poisoning from contagious emanations, whether gaseous or otherwise. For this purpose, the ward should be kept scrupulously clean; all excreta should be removed as soon as possible, and if this cannot be at once done, disinfectants, and especially those containing chlorine or carbolic acid, should be freely used. The ward should contain no unnecessary furniture; there should be no pictures or engravings hung about the walls, and bed-curtains should be strictly forbidden; these all serve as nests to collect any noxious exhalations which may permeate the atmosphere. If any case of erysipelas, pyæmia, or hospital gangrene occur in a ward, the affected person should be at once removed to an isolated apartment, or at least separated as widely as possible from other wounded patients; these diseases, if not directly contagious, at least do harm by impairing the quality of the surrounding air.

FIG. 10.



Ward carriage.

Great care should be exercised in dressing wounds, to avoid all possible sources of infection. For this purpose the "ward carriage," introduced into hospital practice in this country by Dr. Thomas G. Morton, is an admirable contrivance. The most important feature of this apparatus is an arrangement by which water is drawn from a portable reservoir, so that every wound can be washed with a stream of fresh running water. If sponges be employed, every patient should have his own, and they should be frequently renewed; a pledget of tow forms a good substitute for a sponge, and has the advantage that its cheapness permits it to be thrown away after once using. The lint, or other material employed in dressing wounds, should never be used twice; hence the great importance of finding inexpensive substitutes, as has been ingeniously done by Dr. Addinell Hewson and Dr. D. H. Agnew, in introducing paper lint (the best form of which is that made by Parker, of New Haven) as a cheap surgical dressing.

It is well for the surgeon to wash his own hands frequently in going from case to case, and he should enforce scrupulous cleanliness on the part of his dressers and nurses; these may seem trivial matters, but it is upon the attention paid to just such things as these that the well-doing of a surgical ward often depends.

Causes of Death after Operation.—A patient may be in a good condition for an operation, the operation itself may be most skilfully executed, the hygienic conditions by which the patient is surrounded may be excellent, and yet the apparently best-grounded hopes of success may be disappointed by death following the operation, sometimes with great rapidity. There is no subject which has greater claims for the surgeon's consideration than that of the *causes of death after operation*. These causes may, of course, be very various; but there are some which seem to be so immediately connected with the circumstance of an operation having been performed, as to merit special mention in this place.

Shock.—A patient may die from the direct *shock* of the operation. As will be explained more fully when speaking of shock as one of the constitutional effects of external violence, there is a positive physical affection known as shock, to be distinguished from the mental emotion and perturbation which sometimes receives the same name. Hence it is erroneous to say, as is often done, that the occurrence of shock is prevented by the use of anæsthetics; the sensation of pain is indeed done away with, and much of the mental anxiety which was formerly the cause of intense agony before and during an operation[1] is no doubt avoided; but there is a powerful cause of positive physical depression which, in some degree, attends every operation, and to obviate which, no certain means, as far as I know, have yet been found. A patient may come to the operating-table in a perfectly composed and even cheerful frame of mind, remain in a state of complete anæsthesia during the whole operation, and yet, without any great loss of blood or other obvious cause, die within a few hours after its termination, from a purely physical condition of *shock*.

The shock of some operations is much greater than that of others; thus a large amputation, as through the thigh or at the hip-joint, is attended with more shock than one through the leg or arm; the removal of a tumor in the immediate proximity of the base of the skull, is attended with more shock than the taking away of a much larger mass from another part of the body; and there is sometimes observed in the comparatively slight operation of castration, a marked failure of the pulse at the instant of dividing the spermatic cord. The treatment of shock, after an operation, is to be conducted by keeping the patient as quiet as possible, in a recumbent position, and endeavoring to promote reaction by internal and external stimulation. Sinapisms may be applied to the chest, abdomen, and inside of the thighs, and hot bricks, or bottles filled with hot water, should be placed under the bedclothes, so as to produce an equable warmth of temperature. In hospitals, metallic foot-warmers are usually provided, and should always be kept in readiness. While the body is to be kept warm, free access of air to the lungs must be secured by opening the windows, if necessary, and even by fanning. Frictions are often directed, but are of somewhat doubtful utility, as rather tending, in themselves, to exhaust the patient. Brandy and ammonia may be given by the mouth, if the patient is able to swallow, and if not, may be administered by the rectum, or ether may be given by subcutaneous injection. A stimulating enema of oil of turpentine, beaten with yelk of egg, is often very serviceable. Lund employs enemata of quinia and camphorated tincture of opium, while quinia is also recommended as a prophylactic by Easley, and by McGuire, of Richmond, Va. The internal administration of belladonna is advised by Dr. Reinhard Weber, and that of digitalis, in large doses, by Dr. Brunton. As soon as partial reaction has taken place, a full dose of morphia should be given, and this, I think, is preferably done hypodermically. A sixth or a quarter of a grain of morphia, injected under the skin, is more quickly absorbed, and therefore more prompt in its effects, than a much larger dose exhibited in the ordinary way. It is surprising how much benefit a patient suffering from shock will derive from even a quarter or half an hour's natural sleep; a cup of strong beef-tea, well seasoned with pepper, should be in readiness to be administered as soon as the patient awakes.

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[1] A most vivid and painful description of the suffering under amputation before the days of anæsthesia, may be found in a letter from Prof. Wilson to Sir J. Y. Simpson (*Obstet. Mem. and Contrib.*, vol. ii., and *Acupressure*, p. 566).

As there is always risk of reaction running into violent traumatic or inflammatory fever, it is well for the surgeon, as far as possible, to use external stimulation, and those internal remedies which are more evanescent in their effects, such as ammonia, rather than brandy or other preparations of alcohol. It is sometimes necessary to delay the dressing of an operation wound on account of the occurrence of shock; under such circumstances, when reaction has occurred, the dressing should be effected as simply and with as little pain as possible. I have seen grave injury accrue from the introduction of sutures, in the case of patients just recovering from the shock of an operation.

The older writers described what they called "*secondary or insidious shock*," which might come on subsequently to or independently of the occurrence of the primary form. This, which is the most fatal variety of shock, is developed at an interval of from several hours to one, two, or more days after an operation; it is, I believe, in most if not in all cases, dependent on the formation of heart clots,[1] which may cause death by directly embarrassing the action of that organ, or more remotely by fragments becoming detached and plugging the arteries of the brain or lungs, a fatal result being thus caused by the process known as *embolism*. Either primary shock or great loss of blood would, by diminishing the force of the circulation, tend to increase the risk of this formation of heart clots. The most promising mode of treatment consists in the free administration of ammonia, either by the mouth—five grains of the carbonate being given every half hour—or by the intravenous injection of diluted aqua ammoniæ, as recommended by Cotton, of Edinburgh.

Hemorrhage at the time of or subsequent to an operation is very often the cause of death; nothing can be more erroneous than to assert, as is sometimes done, that a moderate loss of blood during an operation is beneficial to the patient. Every drop of blood is valuable, and though we may not go so far as to say, with some of our predecessors, that blood is the liquid life of the body, there can be no question that there is no surer way of making an operation unsuccessful than to neglect even apparently slight hemorrhage. The absolute *amount* of blood lost during an operation is not so immediately the cause of danger as the *rapidity* with which the bleeding occurs. I have seen an amputation at the hip-joint, in which one or at most two or three jets from the femoral artery, together with the shock of the operation, produced a state of collapse from which the patient never rallied; while I have seen a much larger quantity of blood lost in other operations, where the flow was more gradual, and in which the resulting depression was scarcely perceptible. *Intermediate* or *intermediary hemorrhage*, as it is sometimes called, is apt to occur when the patient begins to react from the state of anæsthesia and after he has become warm in bed, from vessels having escaped the surgeon's notice when the force of the circulation was depressed; hence, if there has been much shock, or if the operator has been unable to detect the mouths of vessels which yet he knows must have been divided, it is well to postpone the final closure of the wound until after complete reaction. *Secondary hemorrhage* may come on at any period between the occurrence of reaction and the ultimate healing of the wound; it may result from the premature detachment of ligatures, either from their having been in the first place insecurely applied or from subsequent inflammatory changes in the coats of the vessels, or it may be due to the occurrence of sloughing, opening vessels which had not been divided, or at a part higher than the point of ligation. The treatment of surgical hemorrhage will be described when considering wounds of arteries.

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[1] Fayrer has particularly insisted upon the frequency of death after operations from the formation of fibrinous coagula in the right side of the heart, and believes that a malarious state of the blood acts as a predisposing cause of such coagulation.

A patient may die after an operation, from the violence of the *inflammation* or of the accompanying *traumatic fever* which, except in slight cases, necessarily ensue. The symptoms and treatment of these conditions have been sufficiently discussed in Chapters I. and II., and need not be again referred to here.

A patient may die after an operation from *causes previously in existence* which the operation has not been able to remove, or which it has unavoidably aggravated; as an instance of the former contingency, I may refer to the deaths from hectic and suppurative exhaustion which follow excisions of joints; of the latter, death from pre-existing peritonitis after the operation of herniotomy. The unfavorable influence of *renal* disease upon the results of operations was pointed out many years since by Dr. Chevers, and Verneuil has recently shown that a similarly unfavorable influence is exercised by diseases of the *liver* and other viscera. Fatty degeneration of the *bowel* is believed by Furneaux Jordan to be a cause of persistent vomiting and death after many operations, particularly those upon the abdominal or pelvic organs.

Finally, patients after operation are frequently carried off by various affections, which, while not necessarily dependent on the performance of an operation, yet follow the use of the knife with sufficient frequency to entitle us to consider the operation as their exciting cause. They are chiefly *erysipelas, pyæmia, hospital gangrene, diffuse inflammation of the areolar tissue*, and, more rarely, *tetanus;* these will all be referred to in their proper place, and are mentioned now merely to complete this view of the subject. *Scarlet fever* is regarded by English surgeons as a serious and not uncommon sequel of operations, but I have seen nothing in my own experience to lead me to consider its occurrence other than a coincidence. I have, however, several times seen *erythema* follow operations, and have known it to be mistaken, on the one hand for scarlet fever, and on the other for erysipelas.[1] An operation wound, as any other wound, may become the seat of *diphtheritic deposit*, accompanied by low constitutional symptoms which must be treated on the same principles which guide the practitioner in treating a case of diphtheria occurring under other circumstances.

Preparation of Patients for Operation.—In view of the great dangers which are thus seen to accompany every operation, it certainly behooves the surgeon, whenever it is practicable to do so, to take measures as far as possible to avoid those dangers; and hence the importance of attending to the *preparation of a patient for operation*.

In many cases, unfortunately, there is but little time offered for preparation; a patient with a severe compound fracture requiring immediate amputation, or one who is suffocating with pseudo-membranous croup, cannot wait for any course of preparatory treatment, but must take the chance, if an operation be deemed proper, without regard to the state of his general health; yet even under the most unfavorable circumstances, the *morale* of the patient may often be improved by a few soothing and encouraging words, while, if there be much physical depression, a warming and stimulating draught may suffice to render him better able to submit to the ordeal of the knife than he would be otherwise.

Consent of Patient.—A very important question, and one which admits of grave doubt, is as to how far a surgeon may be justified in assuming the responsibility of operating, when a patient is unwilling to give his assent. Of course no one would think of performing any operation of *complaisance* without the full consent of the patient, but where an operation is immediately necessary to save life, as in a case of strangulated hernia or of injury requiring primary amputation, the surgeon's position is one of great perplexity.

If the patient be a child, the consent of the parents is quite sufficient; if an adult, but unable from intoxication or other cause to judge for himself, the consent of a near relation or friend who is competent to decide the matter should be obtained; in the absence of the parents or other relatives, the surgeon must place himself as it were *in loco parentis*, and do fearlessly what he thinks best for his patient. If, however, an adult in full possession of his faculties refuse an operation, or if, in the case of a child, the parents refuse for him, I cannot think it the duty of the surgeon to persist in operating under such circumstances; he should remember that spontaneous recoveries do occasionally occur in the most unpromising cases, and that, on the other hand, death may very likely follow the most eligible and best-executed operation; and when the true state of the case and the imperative necessity (humanly speaking) of the operation have been clearly and fully explained, I cannot think that the surgeon should be held responsible for the consequences of obstinate refusal on the part of the patient or his friends.

Preparatory Treatment.—The requisite consent having been obtained, in any case that admits of a short delay, it will be desirable to occupy a few days in preparatory treatment. I do not consider it ever necessary to deplete a patient, whether by bleeding or violent purging, before an operation. The diet should be regulated, such articles as are known to be irritating and difficult of digestion being avoided, while the intestinal and other secretions are brought into a healthy condition by the use of mild laxatives, etc. In the case of hospital patients, who are often brought from a considerable distance to undergo an operation, it is proper to wait until they have rested from the fatigues of travelling, and have become somewhat accustomed to their new quarters and the new faces that surround them; as they are frequently in a state of debility, it is often essential to put them upon a course of tonics, with nutritious food, and even free stimulation, before they can be brought into a condition for operation. In the case of diabetic patients, Fischer advises the preliminary administration of carbolic acid in small, but frequently repeated doses.

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[1] See an interesting paper on "Eruptions after Recent Operations," by Mr. E. C. Stirling, in *St. George's Hospital Reports*, vol. x., 1879.

It is usually proper, the night before an operation, to administer a mild cathartic, such as a dose of castor oil, and the next morning to empty the lower bowels by an enema; this is especially important in case the rectum or adjoining parts are to be involved in the operation, but is desirable under all circumstances, as it obviates the need of a fecal evacuation for some days afterwards, and thus saves a good deal of fatigue and exposure which is always undesirable, and occasionally very prejudicial. In the case of a woman, the operation should not be done during a menstrual period or during pregnancy, if the exigencies of the case admit of postponement. The patient should be loosely clad, and, if much bleeding be anticipated, should wear an additional garment which can be removed after the operation. No solid food should be given, if an anæsthetic is to be used, for several hours previous to its administration. All preliminary arrangements should, if possible, be completed before the anæsthetic is given, as there can be no doubt that prolonged anæsthesia exercises an unfavorable influence upon the success of an operation. The rule upon this point must, however, vary with the individual case; thus if an operation on a woman will necessitate exposure of the person, it is obviously better that the anæsthetic should be administered before the patient is removed from her bed, and that the final arrangements should be postponed until she has become unconscious.

Preliminary Arrangements.—The surgeon should himself see that the patient is in good condition for the operation, and that all necessary preparations have been made; the operating-table should be firm and solid, of a height sufficient to prevent the necessity of the surgeon's being fatigued by stooping, and surmounted by a thin mattress covered with oil-cloth and a clean sheet, or by folded blankets; it should be placed in a good light (a northern exposure is usually considered the best), and should be provided with pillows, and additional coverings to throw over the patient. The best time for an operation, in this region of country, is in the forenoon; if it be a dull day, or if the operation be unavoidably performed in the afternoon or evening, the surgeon must see that proper arrangements have been made for providing artificial light. The necessary instruments should be carefully arranged in the order in which they are to be employed, placed in a suitable tray, and covered with a clean towel until the time has come to use them; it is a good rule to think over beforehand all the steps of the operation and the possible contingencies that may arise, and provide the proper instruments accordingly. The surgeon must instruct each of his assistants as to the duties he is expected to perform, and each assistant should, as far as possible, confine himself to his own duties and not interfere with those of the rest. For most operations two or three assistants are sufficient, and few can require more than five, or at most, six. One should take charge of the anæsthetic; another hand the instruments; a third support the part to be operated on; a fourth be ready to suppress hemorrhage, etc. All the needful dressings, sponges, basins, bandages, etc., should be arranged where they can be readily reached. Having seen to all these preliminaries (the patient being in position, anæsthetized, and the part to be operated on divested of superfluous hair and clothing), the surgeon is ready to begin the operation. It may seem almost superfluous to say that on such an occasion the surgeon's personal demeanor should be quiet and dignified; eccentricities of costume and conduct should be avoided, the perfection of an operation consisting greatly in the simplicity of its concomitant circumstances. Though the operator and his assistants may, from natural disposition or from long habit, have come to look upon an operation as an every-day affair, it must be remembered that, to the patient and his friends, it is an occasion fraught with the deepest interest and the most anxious solicitude; hence, both for his own reputation and out of regard to the feelings of others, the surgeon should repress manifestations of excitement, and still more of levity. It may seem needless to dwell so long upon this matter, and I do it only because I have frequently seen these reasonable rules neglected, simply through thoughtlessness. I know of one instance it which, after the first incision was made, an assistant was obliged to remove the operator's hat, lest it should fall into the blood, and in which almost all the bystanders continued to solace themselves throughout the operation with pipes or cigar.

Operation.—The steps of an operation should all be planned in advance, and the less talking that is done after the knife has been once taken in hand, the better. Time is not quite as important now as it was before the days of anæsthesia, but it is certainly not good for the patient if the surgeon be obliged to stop and hold a consultation at each stage of the operation. The incisions should be made as much as possible in the lines of the natural depressions of the part, so that they will come together without undue tension or deformity;[1] they should be sufficiently free, and made with a firm pressure, sufficient to carry the knife through the skin and superficial fascia at the first cut; at the same time the operator should never be in a hurry, and should not be misled by any idea of fancied boldness into stabbing rashly into his patient's body—a course which is never requisite, and which may occasionally lead the surgeon much deeper than he has any wish or intention of going. Hemorrhage during an operation should be prevented by the use of a tourniquet or Esmarch's bandage, or by the pressure of an assistant's fingers; it is even sometimes desirable to pause and secure each artery as it is divided. When the operation is completed and all oozing of blood checked (which may be facilitated, after tying the vessels, by exposing the wound for a short time to the air, or by pouring over it a stream of cold or of quite hot water, or of diluted alcohol), the edges of the incisions should be brought together with sutures. This is best done while the patient is still in a state of anæsthesia, though if there have been much shock or hemorrhage, it should be deferred until reaction has taken place. The sutures may be made of ligature silk, of ordinary thread, or of metal. The lead suture is, I think, preferable for most cases, as it will not bear a very great strain, and thus acts as a kind of safety-valve against undue tension. In other cases, and especially in certain plastic operations, silver or unoxidizable iron wire forms a better material than lead, and when very close approximation is required, the harelip pin may be employed in preference to other forms of suture.

If the wound be extensive, it may be necessary to give additional support by means of adhesive plaster. Narrow strips should be used, to be applied between the points of suture, and to extend some distance on either side of the incision. The wound should then be lightly dressed, and the patient placed in a clean bed, which should be at hand and already warmed. It is often a good plan to give a hypodermic injection of morphia, before the patient has quite recovered from the effect of the anæsthetic. The after-treatment has already been referred to (see page 64).

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[1] Dr. Packard advises that the skin should be cut very obliquely, believing that a smaller cicatrix may thus be secured than could be otherwise obtained.

The surgeon should not, if practicable, leave his patient, until he has seen him comfortably fixed in bed, till complete reaction has occurred, and till he is satisfied that no risk of bleeding is to be anticipated. He should also see that a competent nurse is in attendance, to whom he should give full and explicit directions as to the management of the patient in the intervals between his visits.

ANÆSTHETICS.

It must be acknowledged that a great change has been brought about in the practice of operative surgery by the introduction of *Anæsthetics;* patients will now submit to operations which formerly they would rather have died than endure, and thus many operations which without anæsthesia would have been absolutely impracticable, are now perfectly feasible and are frequently employed. In this way the range of operative surgery has been greatly extended. The advantages derived from anæsthetics are unquestionable; the patient is saved entirely from pain, and in a great degree from the mental anxiety and disquietude which formerly necessarily preceded an operation; and it is probable, likewise, that the physical shock of the operation is in some degree diminished. The surgeon also is enabled to concentrate his attention upon the duty before him, undistracted by the cries and struggles of his patient. But are the benefits of anæsthesia quite unaccompanied with attendant, though by no means countervailing, evils? Statistics have been collected on either side of this question, Prof. Simpson maintaining that the mortality after operations has diminished since the use of anæsthetics, and Dr. Arnott that it has increased. My own impression is that, as a matter of figures, the latter statement is correct. But though there may be an increased death-rate, this increase is not, I believe, fairly to be attributed to the employment of anæsthesia. Formerly, a surgeon, in consideration of the great pain which an operation would inflict, would naturally reserve the use of the knife for those cases in which it was most probable that the patient would be markedly benefited, and would decline interference in any case in which the patient was not in a good condition to undergo the inevitable suffering of the operation: now, since the pain of the operation is no longer to be dreaded, we are constantly induced to extend the benefits of our art to cases which formerly would have been left without operative treatment, and to give a last and possibly faint chance to patients who otherwise would have been abandoned to certain death. In the large majority of cases, the chances for each individual are, I believe, made better by the use of anæsthetics. I have myself repeatedly noted an improvement of the pulse during the inhalation of ether, and have found the patient's general condition absolutely better after an amputation than before it was begun; and I can scarcely conceive of any case in which a serious operation would be proper at all, in which it would not be likewise proper to employ anæsthesia.

Still, we must be careful not to err on the other side. It is to be feared that students and young practitioners often get a false impression upon this point, and from seeing the frequency and apparent profusion with which anæsthetics are administered by their clinical teachers, derive a notion that these agents are perfectly harmless, and may be indiscriminately resorted to under all circumstances. The true rule upon this matter (a rule which is, indeed, applicable to all our perturbing modes of treatment) is, that when anæsthetics are not positively beneficial, they are injurious. Hence, under ordinary circumstances, they should not, I think, be employed, except for really important operations, and those which without their use would be tedious and painful. It is seldom right to give anæsthetics for purposes of *diagnosis* merely: there are, however, parts of the body the lesions of which are so obscure, and in dealing with which a mistaken diagnosis might lead to such grave errors of treatment, that it is often not only justifiable, but even imperative to employ anæsthesia in their examination. Injuries about the hip-joint may be taken as an illustration of this statement. The reduction of dislocations is rendered so much easier to both patient and surgeon by the use of anæsthetics, that these agents may almost always be properly employed in such cases; on the other hand, it is seldom necessary to use them in the dressing of fractures. Cases for what are called *capital operations* (where life is immediately involved), are almost invariably cases for anæsthesia; for smaller operations, the practice should vary according to the time required for their performance; thus, anæsthetics should be given before operating for piles, or for phimosis, for these are tedious precedures; while opening an abscess, cutting an anal fistula, and tapping a hydrocele, are quickly done, and do not usually require the use of these agents.

History.—The history of the introduction of anæsthesia into the practice of surgery is a subject which is full of interest, and well worthy of the attention of every intelligent practitioner. The limits of this work will not, however, permit more than a very brief reference to it.

Many efforts to prevent the pain of operations had been from time to time made, by the use of narcotics, either in vapor or administered internally, by pressure on the nerves of the part,[1] by profuse preliminary bleeding, by electricity, and by other methods; but the first really promising experiment in the introduction of anæsthesia dates back but about a third of a century, to the year 1844,[2] when Dr. Horace Wells, a dentist of Hartford, Connecticut, rendered himself unconscious by breathing nitrous oxide gas (which had previously been experimented with by Sir Humphry Davy), and in that condition submitted to the extraction of a tooth. Dr. Wells repeated his experiment before the medical faculty and students of Harvard College, Boston, but lamentably failed. In 1846, Dr. W. T. G. Morton, another dentist, a pupil and partner of Wells, began to experiment with the vapor of ether, whether independently, or in consequence of hints received from Dr. Wells, Dr. Charles T. Jackson, or both, has never been satisfactorily established. It is stated that Morton's first experiment was made with chloroform (under the name of chloric ether), and hence the honor of discovering both of the great anæsthetic agents of modern times has been claimed for this country. It seems proper, however, that the real credit of a discovery should be given to the man who first practically makes that discovery useful to his fellows, and hence the merit of introducing chloroform as an anæsthetic belongs, I think, as undoubtedly to Sir James Y. Simpson, as does the merit of introducing ether to Morton himself.

The first *surgical operation* (beyond the extraction of a tooth) done with the aid of ether, was the removal of a tumor, by Dr. John C. Warren, at the Massachusetts General Hospital, in 1846, the anæsthetic being administered by Dr. Morton. The first case in which ether was used in this city, was, I believe, one of dislocation, at the Pennsylvania Hospital, the operator being

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[1] More recently the late Dr. Aug. Waller has shown that muscular relaxation and anæsthesia may, in some cases, be effectually induced by pressure on the cervical portions of the vagi (*Practitioner*, December, 1870).

[2] A claim of priority has recently been made on behalf of Dr. Crawford W. Long, of Georgia, who is said to have used ether in surgical operations as early as 1842. I hope that I may be pardoned for saying that the evidence in Dr. Long's favor seems to me quite inconclusive.

Dr. Edward Peace. In the fall of 1847, Prof. Simpson, of Edinburgh, began to experiment with chloroform, which soon became the favorite with British and Continental surgeons, by whom it is still almost universally preferred to ether. The latter substance is, on the other hand, preferred in some parts of France, and very generally in this country.

Either agent has some advantages over the other, and some corresponding disadvantages. Chloroform is more prompt in its effects than ether, the patient is usually quieter while coming under its influence, it is less apt to cause vomiting, a smaller quantity than of ether is required to produce anæsthesia, and the patient reacts more quickly when the inhalation is stopped. It, however, requires much greater care in its administration than ether, and its use is attended with much greater risk to life. The above statement gives my own estimate of the relative merits of these agents, and, I believe, corresponds pretty closely with the opinions usually entertained on the subject; it is, however, but right to say that Dr. Lente and Dr. Squibb, of New York, believe that anæsthesia may be induced by means of ether as quickly as can safely be done by means of chloroform, and with a quantity costing less and weighing very little more than the requisite amount of the latter; and that other writers have maintained that vomiting is at least as frequently caused by chloroform as by ether. Dr. Kidd, on the other hand, regards ether as quite as dangerous as chloroform (*Dub. Qu. Journ. Med. Sci.*, Aug., 1867, p. 63).

For my own part, I confess that I prefer ether, in a very large majority of cases; it is certainly, I think, safer than chloroform, and is sufficiently convenient for almost every case that the surgeon is called upon to treat. In particular cases, however, I am in the habit of using chloroform; thus in extraction of cataract, the greater struggling and risk of vomiting produced by ether are decided contra-indications to its use; and as the vapor of ether is very inflammable, and that of chloroform not at all so, the latter should be preferred for operations about the face, when there is any possibility that the use of a hot iron may be required.

Precautionary Measures.—Whatever anæsthetic be resorted to, certain precautionary measures should be employed in its administration. It is often said that organic visceral disease, especially a fatty state of the heart, should forbid the use of anæsthetics; but whatever may be the risk under these circumstances, it would probably be still greater if the operation were performed without an anæsthetic, and hence I cannot think its use in such cases improper. It would, however, be right, if disease of the heart were suspected, to watch the administration with special care, and particularly to give no more of the anæsthetic than was absolutely necessary. The patient should be prepared by removing any constriction of the clothing upon the throat or around the waist, so as to prevent pressure on the larynx, or interference with the action of the diaphragm. No solid food should be taken for several hours before the anæsthetic is given, though, if there be much depression, it is often well for the patient to swallow half an ounce or an ounce of brandy, with a moderate dose of opium or morphia, immediately before the administration is begun; if the operation be necessarily prolonged, further restoratives should be given from time to time, the use of the anæsthetic being suspended sufficiently to allow the action of deglutition to be performed. The patient is best placed in the recumbent position to inhale any anæsthetic, though this is less important in using ether than in using chloroform, when it is absolutely essential. The inhalation should be begun gradually, so as not to alarm the patient by the impending sense of suffocation, and all unnecessary noise should be avoided, as tending to produce undue excitement and delay the induction of insensibility.

Effects of Anæsthetics.—The first effect of an anæsthetic is upon the nervous system; there is excitation, usually pleasurable, followed by insensibility to pain, and complete unconsciousness, though some of the muscles may remain slightly rigid and tense, and reflex motion be not totally abolished; this is the most favorable condition for many operations which do not require extreme delicacy, such as amputation, excision of tumors, etc., when absence of sensation and voluntary motion is all that is requisite.[1] In the next stage there is complete relaxation of the muscular system, while the force of the circulation and respiration is much diminished. This condition must be induced for the performance of the more delicate operations, and for the reduction of dislocations. The approach of this stage may be known by the test of touching the conjuctiva; if reflex motion be suspended, this action will not produce winking. When anæsthesia is pushed beyond this stage, the patient must always be looked upon as in a very critical state. The pulse, the respiration, and the color of the face must all be constantly watched, and the anæsthetic either removed or continued in lessened quantity and with extreme care. *Stertorous breathing*, as pointed out by Prof. Lister, is of two kinds: one, the *palatine*, which is caused by vibrations of the soft palate, may occur early (as in ordinary snoring), and is not necessarily important; the other, or *laryngeal* stertor, depends on the vibrations of the portions of mucous membrane which surmount the apices of the arytenoid cartilages, and is always indicative of extreme danger. Death from the administration of an anæsthetic may come from failure of either foot of the vital tripod, the head, the lungs, or the heart; in other words, it may be due to *coma*, to *asphyxia*, or to *syncope*. As a matter of practical experience, it is very difficult to distinguish which of these conditions may have been the primary one, for whichever organ fails first, the others cease to act in a very short time afterwards. As shown by Prof. Lister, the appearance of respiration may continue after the supervention of true laryngeal stertor shows that the access of air to the lungs is greatly impeded, if not absolutely checked; hence deaths are sometimes attributed to paralysis of the heart, which are really due to asphyxia, or, more correctly, apnœa. The following is the course to be pursued whenever death appears imminent during anæsthesia: The inhalation must be immediately stopped, and the patient supplied with fresh air by opening windows, etc. He should be turned on his side to allow fluid to escape from the mouth, but should on no account be raised from the recumbent posture. Nélaton, Sims, and others, believing that the risk in chloroform poisoning is from cerebral anæmia, advise that the patient should be inverted, so as to favor the flow of blood to the brain. Inhalations of nitrite of amyl are suggested by Schüller, and by Burrall, of New York, and have been successfully employed by Bader and others. The lower jaw should be forcibly pushed forwards, or the tongue drawn out as far as possible, with tenaculum or artery forceps; extreme protrusion is necessary to insure opening of the larynx. Artificial respiration should be at once employed, and is most conveniently effected by alternately compressing and expanding the walls of the chest. Electricity may be applied over the region of the heart and diaphragm, and through to the spine, while cold water may be dashed over the face and chest, and frictions applied to the extremities. Fitzgerald, of Melbourne, suggests intravenous injections of ammonia, while Baillié advises the introduction of ice into the rectum. As soon as the patient is able, he should swallow a little brandy. If it should be necessary to reapply the anæsthetic, it should be done with renewed caution and watchfulness. Noel, of Louvain, having constantly observed a *venous pulse* in the jugular and subclavian veins during the stage of awaking from chloroform anæsthesia, considers this an evidence of profound functional disturbance of the heart, and urges that the patient should be carefully watched as long as this phenomenon continues.

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[1] Dr. Packard has described, under the name of "first insensibility from ether," a condition, of brief duration, in which such operations as opening an abscess or felon can be performed without suffering on the part of the patient, and without pushing the administration of the anæsthetic to the extent of producing complete insensibility. Dr. Gibney has observed a similar state of "primary anæsthesia" in the use of chloroform. Dr. Hewson and Dr. Bonwill state that a condition of "analgesia," sufficient for the endurance of minor operations, may be induced simply by rapid breathing.

Secondary Effects.—Certain secondary consequences of an unpleasant nature are occasionally due to the use of anæsthetics. These are headache, sick stomach, and bronchial irritation. In nervous women, hysterical symptoms are sometimes developed, which may continue for some time and cause a good deal of annoyance. It is said that apoplexy or paralysis is sometimes produced in old persons by the use of anæsthetics, but I have never met with such an occurrence in my own practice. The nausea and vomiting which very frequently follow the use of these agents, and especially ether, may be usually relieved by giving small quantities of milk and lime-water, or of iced carbonic-acid water; in more severe cases, chloroform, given in doses of twenty or thirty drops in emulsion, will be found very effective. The occurrence of these annoying symptoms may often be prevented by giving a hypodermic injection of morphia before the state of anæsthesia has passed off, and thus allowing the system to recover itself by a few hours' sleep. The bronchial irritation may be relieved by keeping the patient quiet and giving a mildly sedative expectorant, such as the wild-cherry bark with a little opium or hyoscyamus; in some cases, however, the lung itself becomes affected, being deeply congested, and a low form of pneumonia or a kind of suffocative catarrh may follow, and may possibly prove fatal in the course of a few days. This is a serious occurrence, and must be met by giving stimulating expectorants, such as carbonate of ammonium and senega, and by the administration of wine or brandy, according to the general condition of the patient.

These unfortunate consequences may follow, even when the anæsthetic has been given with the greatest care and judgment; they are, however, more likely to ensue when too large a quantity has been used, when the administration has been too long continued, or (in the case of chloroform) when it has been given without a sufficient admixture of air.

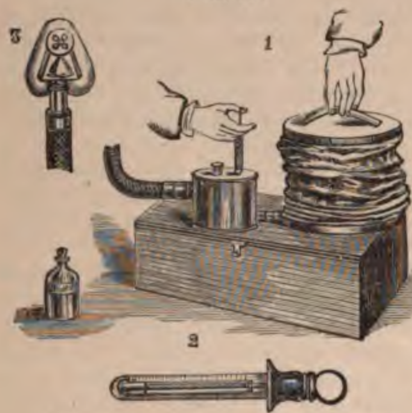
Administration of Ether.—The best mode of giving *ether* is from a thin and hollow sponge, wrung out of water, and surrounded by a pasteboard or light metallic cone, which should be perforated at the top. The hollow of the sponge should be large enough to embrace both mouth and nostrils. The ether should be chemically pure, and should be poured upon the sponge in quantities of not less than half a fluidounce at a time. The first few inhalations should be made while the sponge is a few inches distant from the nostrils, but as soon as the state of anæsthesia has begun, the sponge may be closely applied, and need not usually be removed, except when necessary to add more ether, till unconsciousness is complete. Of course, if, as will sometimes happen, the patient be seized with a fit of coughing, and choke, or, from having eaten a meal immediately before the operation, should begin to vomit, the sponge must be withdrawn until tranquility be restored. If a patient breathe freely, he cannot be *too rapidly* etherized, and there is no danger, as in the case of chloroform, from the vapor being too concentrated. Enough air is drawn through the perforation of the cone and the interstices of the sponge to obviate any risk from this cause, and rapid etherization is much less apt to cause pulmonary congestion than slow inhalation of the vapor prolonged through a considerable period; still, as a patient may choke from various causes, as from an accumulation of saliva and mucus flowing backwards over the glottis, or from vomited matters collecting at the back of the mouth, a constant watch should be kept upon the countenance and the respiration, and the approach of any dangerous symptoms promptly met.

The patient can greatly assist the production of anæsthesia by taking deep inhalations; he should, therefore, be constantly urged by the surgeon, not, as is often done, to "draw in his breath," but to "blow out," to "blow the sponge away from him." This is a practical hint which I learned from that excellent surgeon and brilliant operator, Prof. Joseph Pancoast, of this city, and a moment's reflection will show that, though paradoxical, it is reasonable and strictly correct: the vapor of ether is so penetrating and irritating to the throat, that it is very difficult *voluntarily* to draw it in by a deep inhalation; but it is perfectly easy to blow into the sponge, and, as a full expiration is inevitably followed by a deep inspiration, the surgeon's purpose is thus most readily accomplished.

The plan of administering ether which has been described, is both efficient and economical, and I doubt if it can be practically improved. The old method, by a sponge simply surrounded with a towel, is equally efficient, but allows more evaporation, and, therefore, wastes more ether. Dr. Lente uses a cone of newspaper, with a towel pinned inside, and so folded as to prevent any, even the slightest, admixture of air; and Dr. A. H. Smith has devised an ingenious portable apparatus, which consists of a large India-rubber ball (such as is sold for a football) lined with patent lint, and with an aperture cut for the face. Prof. Porta, of Pavia, stuffs the nostrils with cotton, and causes the patient to inhale the ethereal vapor from a pig's bladder closely fitted to the mouth. Other inhalers, more or less complicated and ingenious, have been devised for the administration of ether (including those of Drs. Lente, Squibb, Allis, and Rohe, and those of Messrs. Morgan and Richardson, of Dublin), but I am not aware that they possess any practical advantages over the simple method which I have recommended. Whatever apparatus be used, great care should be taken that no compression be exercised upon the larynx. The lips and nose may be anointed with simple cerate or cold cream, to prevent any cutaneous irritation from the contact of the ether.

Chloroform is, I think, best given from a folded handkerchief or piece of lint, held at first five or six inches from the nose, and afterwards brought as near perhaps as half an inch to an inch, but never allowed to touch. Not more than a fluidrachm of chloroform should be poured on at once, and evaporation may be prevented by throwing a single towel loosely over the operator's hand and patient's face. This is not as safe an agent as ether, and one of the principal dangers in its administration is the risk of too great concentration of its vapor; hence the surgeon should constantly bear in mind the importance of allowing a sufficient admixture of air, and should err on the side of allowing too much rather than too little. The average amount of chloroform required for an ordinary operation is from half an ounce to an ounce; though Prof. Gross states that he has given as much as twenty ounces in two hours, without any unpleasant consequences following. Various inhalers have been devised with a view of regulating the amount of chloroform used, and of securing the proper admixture of air, and when the administration has to be conducted by one unaccustomed to the employment of chloroform, probably one of these instruments may advantageously be resorted to; but in the hands of an experienced person, I believe that the greatest safety to the patient is that sense of immediate responsibility which should always be felt by the giver of chloroform, and that hence the best inhaler may occasionally prove injurious by inspiring a false sense of security. Mr. Clover's apparatus, which is probably the best, is thus described by Erichsen: It consists "of a bag holding 8000 cubic inches of air, which is suspended from the coat-collar at the back of the administrator, and connected with the face-piece by a flexible tube. The bag is charged by means of a bellows (Fig. 11, 1) measuring 1000 cubic inches; and the air is passed through a box warmed with hot water, into which is introduced at each filling of the bellows as much chloroform as is required for 1000 cubic inches of air. This is done with a graduated glass syringe Fig. 11, 2) adjusted by a screw on the piston-rod to take up no more than the quantity determined on, which is usually from 30 to 40 minims. When the bag is full enough, the tube is removed from the evaporating vessel, and the mouth-piece (Fig. 11, 3) adapted to it. The patient cannot get a stronger dose than the bag is charged with; but the proportion can be made any degree weaker, by regulating the size of an opening in the mouth-piece, which admits additional air."[1] Even with this instrument, according to Kappeler, at least five fatal cases have occurred, and I believe that no mechanical arrangement, however accurate, can take the place of the personal care and attention of the surgeon.

FIG. 11.



Clover's chloroform apparatus. (ERICHSEN.)

A *mixture* of ether and chloroform is frequently used in this country, and many surgeons believe that by this plan they unite the advantages and avoid the evils of both agents. For my own part, I do not think that any benefit is to be derived from the employment of mixed vapors, more than is obtained from the use of ether alone; and I have seen, at least once, such serious symptoms follow the use of this combination, that the operation had to be temporarily abandoned, when the patient was only restored by a prompt recourse to artificial respiration.[2]

Various other substances, principally belonging to the group of ethers, have been found to possess anæsthetic properties, and have been occasionally employed in surgery: none of them, however—not even the bichloride of methylene, which is employed by Spencer Wells, nor the bromide of ethyl, as used by Levis, of this city, nor the ethidene dichloride, recommended by the Committee of the British Medical Association—have proved so satisfactory as to take the place of the two agents, the use of which has been above described. The same may be said of the *intra-venous injection of chloral*, as recommended by M. Oré, and other European surgeons.

Nitrous oxide, or *laughing gas*, which, it will be remembered, was the substance employed by Dr. Wells in his early experiments, has lately been re-introduced in this country, and is quite extensively used in dental practice. I have seen an amputation done while the patient was rendered unconscious by the use of this gas, and though the symptoms presented were sufficiently alarming, it certainly seemed an effective agent as far as the prevention of pain was concerned. It appears to act by inducing an asphyxial condition, which, of course, cannot be long continued with safety to the patient, and it is hence seldom employed in general surgery, except as preliminary to the administration of ether, though it is constantly used in the extraction of teeth. It has been recently suggested by M. Paul Bert, that the risks of giving nitrous oxide might be obviated by mixing with it oxygen gas, and administering the mixture in a chamber of compressed air; and several successful operations upon this plan have been performed by Labbé and Péan.

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[1] Science and Art of Surgery, vol. i., p. 44.

[2] Wachsmuth advises that the vapor of *turpentine* should be combined with that of chloroform, by mixing one part of the former substance with five of the latter.

Local Anæsthesia is sometimes useful in preventing the pain of slight operations, where unconsciousness on the part of the patient is unnecessary or undesirable. It is usually produced by the application of cold to the part to be operated on, either by means of a mixture of ice and salt, as recommended by Dr. J. Arnott, or by the rapid evaporation of ether, rhigolene, or other very volatile substance, as proposed by Dr. Richardson. The freezing mixture may be applied in the proportion of two parts of powdered ice to one of salt, being kept from the surface to be anæsthetized by inclosure in a bag of gauze or of thin muslin. Ten to fifteen minutes' application is usually sufficient to insure the freezing of the skin, which becomes blanched, opaque, and tough, and may then be incised without suffering on the part of the patient. Dr. Richardson's method consists in applying a fine spray of pure ether in the line of the proposed incision, by means of a hand atomizer. The same writer recommends that where this method is employed, the incisions should be made with scissors instead of a knife. According to Dr. Letamendi, the occurrence of anæsthesia may be hastened by making a slight incision, not deeper than the papillary layer of the cutis, as soon as the part to be frozen has become red under the application of the ether spray. Local anæsthesia has been used successfully in an operation as important and severe as ovariotomy; I cannot but think, however, that general anæsthesia is preferable for all but very slight operations, if for no other reason, on account of avoiding the mental shock which is entirely distinct from the sensation of pain. Moreover, the process of freezing is itself very painful in some instances, especially when mucous membrane is involved, as in the case of hemorrhoids, and the use of the ether spray is not entirely free from danger; thus, in a case of excision of the tunica vaginalis for hydrocele, which occurred in this city, the use of the spray was followed by extensive sloughing of the scrotum, which well-nigh cost the patient his life.

Another mode of producing local anæsthesia, which is highly commended by Squibb, Wilson, and Bill, is the topical application of *carbolic acid.*

Before leaving the subject of anæsthetics, I may give the student one caution, which is never to give an anæsthetic to a woman, unless in the presence of witnesses. A curious but undoubted property of these agents is, that they occasionally produce most vivid erotic dreams, and this may happen even with a patient whose mode of life and character are above suspicion. Several most vexatious prosecutions, and even convictions, for indecent assault, have occurred in this country, where yet calm after-investigation rendered it almost morally certain that no assault had been committed, and that the plaintiff's sensations had been quite deceptive, and due to the effect of the anæsthetic which had been administered. Hence a woman may, without any evil intention, and really believing that she is telling the truth, inflict an irremediable injury on a medical practitioner, if he cannot by the evidence of eye-witnesses prove the incorrectness of her assertions, and thus establish his own innocence.

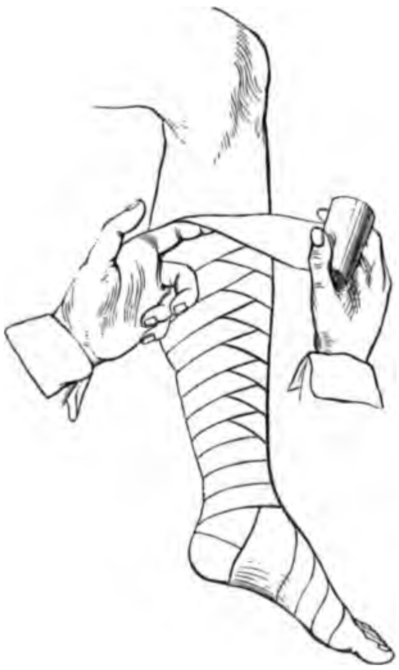
CHAPTER IV.

MINOR SURGERY.

It is not intended to embrace in this chapter a description of all the operations which are usually treated of in works on Minor Surgery; some of these procedures have already been referred to, and others may be more appropriately considered when discussing the various conditions which demand their employment. I purpose now merely to describe certain minor surgical manipulations which are applicable to a great variety of cases, and which seem therefore to find an appropriate place in this preliminary division of the work.

Bandaging.—Bandages are used to retain surgical dressings, to exercise compression, to assist the coaptation of wounds, or to keep injured parts at rest, as in the treatment of fractures and dislocations. The most convenient form of bandage, and one which is almost universally applicable, is made by tearing unbleached muslin or other material into strips from two or four inches wide, and from five to eight yards in length. One-inch bandages are occasionally used for application to the fingers or penis, but strips of adhesive plaster are generally more convenient for retaining dressings to these parts. A bandage two inches wide is suitable for the head or neck; one three or three and a half inches wide for the arm or leg, and a four-inch bandage for the thigh. Still wider strips, five or six inches, are required for the trunk. To be ready for use, these bandages are tightly rolled, either by hand or by a little apparatus which is figured in most works on minor surgery, and which is convenient for use in hospitals, or where a great many bandages are daily employed. When thus prepared, the bandage is called a *roller*, or a *roller bandage*. Some surgeons use bandages rolled from both ends, or *double-headed rollers*, but the *single-headed roller* is more generally applicable, and indeed is sufficiently convenient for every practical purpose. The ordinary bandages used by the surgeon are the spiral, the figure of 8, or spica, and the recurrent.

FIG. 12.

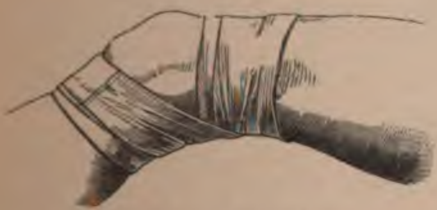


Reversed spiral of the lower extremity.

Spiral Roller Bandage.—As most persons use the right hand with greater facility than the left, the bandage is usually held in the right hand, and applied from left to right above (or in the direction in which the hands of a watch moves), as regards a transverse section of the part to be bandaged. As a rule, also, the roller is started at the distal part of the limb to be bandaged, and made gradually to approach the trunk. The surgeon should, however, accustom himself to bandage with the left hand as well as with the right, and downwards, or in a direction receding from the trunk, as well as upwards. The *plain spiral* bandage, as its name implies, consists of simple turns of the roller around a limb or other part in a spiral direction. It is applicable only where the part to be bandaged has a uniform diameter, as in the limbs of very thin persons. Where the limb is conical, rather than cylindrical, the *reversed spiral* is to be applied. In making the *reverses*, the surgeon fixes the previous turn of the bandage with the fingers of the left hand, and holding the roller lightly in the right hand, gives it a quick half turn, so as to cause the part which is unrolled, and which should not be too tightly drawn, to fold evenly upon itself; the roller is then carried around the limb as in the ordinary spiral bandage. It will be found advantageous, in applying the reversed spiral, to alternate the reverses with plain turns, or, if the limb be too conical to admit of this, to cover in every two or three reverses with a plain spiral turn; the effect is indeed less agreeable to the eye, but a bandage thus put on is much more likely to retain its position than one consisting of reversed turns alone.

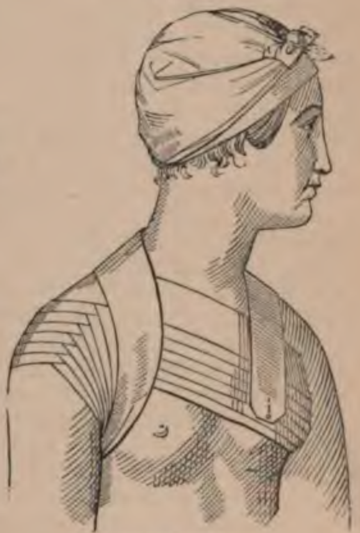
Figure of 8 *or Spica Bandage.*—This bandage is used for application to the various joints. It consists of simple turns of the roller, which pass above and below the joint, and cross each other at any convenient point, usually at the flexure of the articulation. The term *spica* is applied to the figure of 8 bandage for the ankle, the hip, or the shoulder. In the case of the shoulder, one branch of the spica goes around the arm, while the other may be applied to the neck, though more usually and better to the chest. A figure of 8 bandage may likewise be used around both shoulders, to draw them together, or when applied so as to bring the crossing in front, may be made available in giving support to the female breast.

FIG. 13.



The posterior figure of 8 of the knee.

FIG. 14.

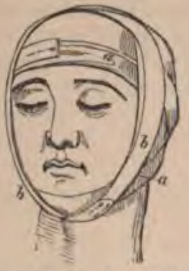


The spica of the shoulder.

Recurrent Bandage.—The recurrent bandage is principally used in applying dressings to the head or to a stump. One or two circular turns are first made around the head or the upper part of the stump, and the bandage is then brought in recurrent semicircles backwards and forwards from the forehead to the occiput, or over the face of the stump, as the case may be; the recurrent turns are secured by additional circular turns corresponding to those first made.

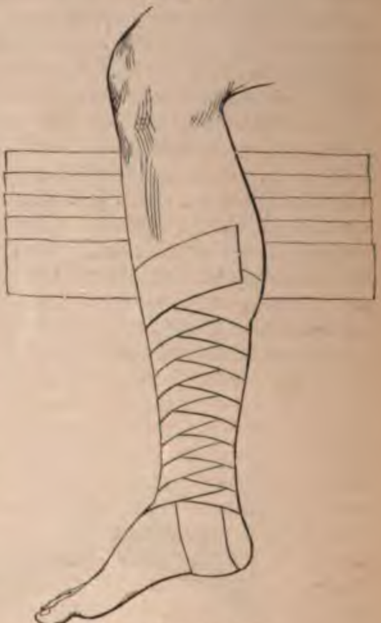
Compound Roller Bandages.—Besides the bandages above described, which are all made from a single roller, various more complicated appliances may be occasionally useful. Those most often employed are the single and double **T** bandages, the four-tailed bandage, and the many-tailed bandage, or that of Scultetus. The **T** bandages, the forms of which are described by their names, are convenient for retaining dressings to the perineum; the single **T** being applicable to the female and the double **T** bandage to the male. The four-tailed bandage, which is made simply by splitting both ends of a piece of a broad roller, may be conveniently used for the knee-joint, or in cases of fractured jaw, while the bandage of Scultetus, which consists of numerous short overlapping strips of bandage (Fig. 16), may be sometimes resorted to in the treatment of compound fractures.

FIG. 15.



The four-tailed bandage of the chin.

FIG. 16.

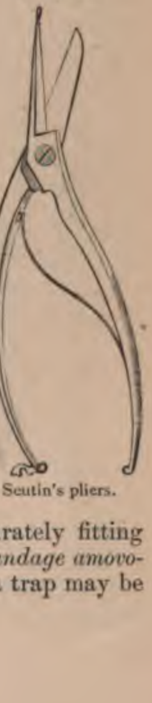


Bandage of Scultetus.

Handkerchief Bandages.—An ingenious Swiss surgeon, M. Mayor, introduced, some forty or fifty years since, a new system of bandaging, in which broad handkerchiefs, or squares of muslin or other material, took the place of the ordinary roller. The handkerchiefs were to be folded into triangles or into cravats, and it is surprising to see, from the illustrations which accompany Mayor's essay, to what a great variety of circumstances these simple means are applicable. Though the handkerchief can never supersede the roller, nor indeed rival it in general utility, yet it is well for the surgeon to bear in mind the possibility of resorting to this system, as an emergency might well arise in which the handkerchiefs of bystanders could be more easily obtained than any other means of bandaging.

Fixed or Immovable Bandages.—Various substances have been employed of late years to give greater firmness and solidity to the ordinary roller bandages, and may be applied either to the common spiral and spica bandages, or to that of Scultetus. The most usual forms of immovable bandage are those made with starch, with gypsum or plaster of Paris, with gum and chalk, with dextrine, with simple flour paste, with the silicate of potassium, or with paraffine. Whatever material be used, there is apt to be some constriction exercised upon the limb in the process of drying, and hence it is best to protect all the bony prominences with a moderately thick layer of cotton wadding, the elasticity of which will prevent any injurious consequences from this cause. The *starched bandage* requires two rollers, the inner one of which is saturated with thick starch, the outer one being left dry, or only starched on its inner surface as it is applied. The starched bandage requires from thirty to fifty hours to dry, and is on this account not so convenient as that made of plaster of Paris. For the *gypsum* or *plaster-of-Paris bandage*, a roller, which should be coarse and of loose texture—crinoline is a suitable material—is prepared by rubbing into it the dry powdered plaster of Paris. It is dipped in water for a few seconds to prepare it for use, and is then applied as an ordinary spiral, over an ordinary muslin bandage, or a closely-fitting stocking. When its application is completed, it is smeared over with a little dry plaster of Paris. This bandage has the advantage of becoming firm in about a quarter of an hour, and constitutes, I think, the best form of immovable apparatus. It is an excellent dressing for fractures of the lower extremity after the union of the fragments has become moderately firm. *Tripoli* is preferred to plaster of Paris by Langenbeck. The *gum-and-chalk* bandage requires mucilage and chalk to be rubbed together in a mortar till a mixture of a creamy consistence is obtained; this is then smeared over a dry roller, previously applied. It requires four or five hours to become dry. The *dextrine* bandage was particularly recommended by Velpeau; the dextrine, or British gum, is to be dissolved in camphorated alcohol (ten parts to six), and when of the consistence of honey, five parts of hot water to be added, when, after shaking for a few minutes, it is ready for use. Velpeau used two rollers, the first dry, and the second soaked in the dextrine before application. The *flour-paste* bandage is applied like those of starch or dextrine, and is considered by Prof. Hamilton to be as satisfactory as either. The *silicate of potassium* (liquid or soluble glass) has been used by several German, French, and American surgeons as a substitute for starch in the application of immovable bandages, and has the advantage of drying more rapidly (in from four to twelve hours, according to the number of bandages used), and of being easily softened by the use of hot water when it is desired to effect its removal. From two to six layers of bandage may be employed, the silicate being applied in a state of syrupy consistence by means of a brush. The silicate of potassium has been lately particularly recommended by Prof. Darby, of New York, and *glue*, mixed with *oxide of zinc*, by Dr. Levis, of this city. Melted *paraffine* is employed by Tait and Macewen, the former applying it upon flannel bandages, and the latter upon sheets of cotton-wool. Immovable bandages may be applied by themselves, or may be reinforced by the employment of light splints, made of thin wood or metal, leather, gutta-percha, or pasteboard. If, as often happens, the apparatus becomes loosened after a few days, from the subsidence of swelling, it may be slit up on one side with a strong-backed knife, or with a pair of Seutin's, Wathen's, or Von Bruns's pliers, the edges being then trimmed, and held in place after readjustment with tapes or bandages; or, as suggested by Darby, holes may be bored in either edge, and the apparatus then laced up as a boot. By slitting up an immovable bandage on *both* sides, two light and accurately fitting splints are formed, constituting what the French call a "*bandage amovo-immobile.*" When applied to ulcers or compound fractures, a trap may be cut opposite the seat of lesion of the soft parts.

FIG. 17.



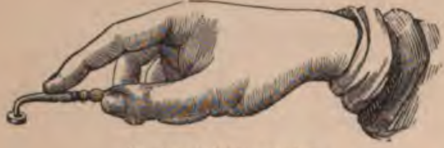
Seutin's pliers.

Revulsion and Counter-Irritation.—Counter-irritation is often employed by the surgeon, and may vary in the intensity of its effects from the slight redness produced by a brief application of a mustard poultice, to the extensive sloughing caused by the actual cautery.

Rubefaction.—The most convenient rubefacients are mustard-flour and oil of turpentine. The latter is applied warm upon flannel, while mustard should be mixed with water and applied in the form of a poultice, which may be rendered milder in its effects by diluting the mustard with Indian-meal. A very convenient application is what is sold under the name of "prepared sinapism," made by causing the mustard-flour to adhere to paper by means of gum; it is made ready for use by simply dipping it in warm water.

Vesication may be produced in a variety of ways. The most usual is by means of the ordinary blister plaster, made with the officinal cantharidal cerate of the pharmacopœia; cantharidal collodion may be painted over the part to be blistered, and, if the skin be not too thick, will be found a very prompt and convenient mode of producing vesication; or the solid stick of nitrate of silver may be used as a vesicant, or the strong aqua ammoniæ, or iron heated by immersion in boiling water. The last method is best employed by means of Sir D. Corrigan's "thermal hammer," or "button cautery." When vesication is produced by the use of cantharides, it is well, in order to guard against strangury, to withdraw the blister when it has begun to act, and to complete the "raising" of the vesicle by the application of an emollient poultice. If it be desired to produce a *permanent blister*, the raw surface may be dressed with cantharidal or savine ointment, or other irritating substance. The *endermic* method of medication, which was formerly more used than it is now, consisted in applying various drugs, especially morphia, to a freshly blistered surface; this plan of treatment, though efficient, is now almost altogether superseded by the *hypodermic* mode, which is usually preferable.

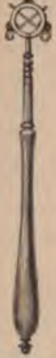
FIG. 18.



Corrigan's button cautery.

Issues may be established by the employment of moxa, by means of various caustics, or by the knife. *Moxa* may be made of different materials, the simplest, and therefore the best, being cotton-wool or lint saturated with a solution of nitre, and rolled, after drying, into the form of a cone. This should be applied by means of an instrument called a "porte-moxa," or moxa-bearer, and should be ignited at the top of the cone, the surrounding tissue being protected by means of wet lint. The moxa is a very painful application, but is probably the best means of making an issue when a profound impression is desired. Caustic issues may be made with Vienna paste; this is a mixture of five parts of caustic potassa with six of quicklime. It is made into a paste with alcohol, and applied through a perforation in a piece of adhesive plaster. Fifteen or twenty minutes' contact will usually insure the formation of a sufficient eschar. An issue may be made with the knife, by making a simple or a crucial incision, preferably by transfixing a fold of skin and cutting outwards. When suppuration is fairly established, the issue may be kept open by the use of irritating ointments, or by the application of glass beads or issue peas, held in place by strips of plaster.

FIG. 19.

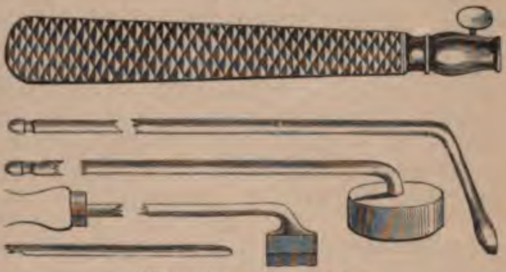


Porte-moxa.

Setons.—A seton is a sinus, kept from healing by the introduction of a foreign body; it is, in fact, an issue with two orifices. In the subcutaneous tissue a seton may be established by means of a long and broad needle, which carries a thread or strip of muslin (to be left in the wound), or by transfixing a fold of skin with a sharp, straight bistoury, and passing an eyed probe carrying the foreign body along the track of the knife. A seton may be kept open for a long time, when it is intended to act as a derivative, or it may be temporary merely, when the object is to excite a limited degree of irritation.

Actual Cautery.—The cautery is the most powerful counter-irritant which the surgeon possesses. It is applied by means of irons of various shapes, heated to a red or white heat in a convenient charcoal furnace. The *gas cautery* is used by directing a jet of burning gas upon the part to be cauterized, while the *galvanic cautery*, originally suggested by Heider, and made practically useful by Marshall and Middeldorpff, consists of a pair of forceps with long and narrow blades, holding copper or platinum wires, which are applied cold, and afterwards heated by means of the galvanic current. Ritter has invented, and Faure has improved, a "secondary battery," by which electricity can be stored away, as it were, for future use. This very ingenious addition to the galvanic cautery has been successfully employed by Buchanan, of Glasgow. Paquelin has recently introduced a modification of the actual cautery, which acts by utilizing the property of heated platinum-sponge to become incandescent when exposed to the action of certain gases.

Fig. 20.



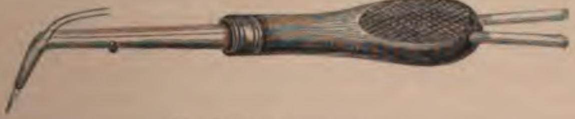
Different forms of cautery iron.

Acupuncturation is sometimes used as a means of counter-irritation in cases of neuralgia, etc., or to allow effused fluids to drain off, as in cases of œdema. It is effected by introducing long and slender needles with a slow rotatory motion, accompanied with slight pressure, taking care not to wound important structures.

Electro-puncturation is effected by passing a current of electricity through the ordinary acupuncture needles, which are previously introduced.

Hypodermic Injection.—The hypodermic method of treatment is now very much used, and it is probable that its full capabilities have not even yet been developed. The physician employs a considerable variety of drugs by this method, but the only remedy which has been as yet much used in surgery by hypodermic injection is morphia, though some experiments have lately been made with mercury thus administered in cases of syphilis, and with ergot in cases of fibroid tumor of the uterus. The most convenient preparation of morphia for hypodermic use is the strong solution of the sul-

Fig. 21.



Marshall's galvanic cautery.

phate, known as Magendie's solution. Its strength is sixteen grains of the salt to the fluidounce, and eight minims, therefore, contain about a quarter of a grain of morphia, which is a large enough dose to begin with. The cylinder of the hypodermic syringe should be of glass, and graduated to minims, and the piston should fit accurately. In giving a hypodermic injection, the surgeon should pinch up a fold of skin with the fingers of the left hand, and thrust in the nozzle of the syringe with a quick motion and in a somewhat oblique direction; great care must be taken to avoid any subcutaneous vein, as from neglect of this precaution serious symptoms of narcotic poisoning may be rapidly induced, the drug being instantly thrown into the circulation, instead of being gradually introduced by absorption from the subcutaneous areolar tissue. The nozzle of the syringe should be kept sharp and *scrupulously clean;* if it be not clean, its use is apt to be followed by considerable irritation, and sometimes the formation of a small abscess; a result which I have never known to follow the hypodermic injection of Magendie's solution with a clean syringe. The hypodermic injection of *ether* has been successfully employed in cases of surgical shock, as well as in those of collapse from post-partum hemorrhage.

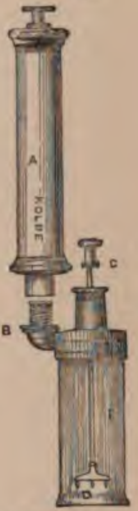
Vaccination.—Vaccination is usually performed by the physician or accoucheur, rather than by the surgeon; still, it may be regarded as a surgical operation, and a brief reference to it will, therefore, not be out of place. Vaccination may be effected either with the lymph of the vaccine vesicle, or with the dried scab; the latter is very commonly employed in this country, and is usually quite satisfactory. The scab should be of a dark amber color, and not too thin; a sufficient portion is to be shaved off with a lancet, and rubbed up with a few drops of water till it forms a mixture of creamy consistence. The skin is then to be slightly abraded with a *dull* lancet, until the slightest pink tinge is perceived, when the vaccine matter is to be applied, and slowly worked in. Some surgeons prefer to introduce the vaccine matter by two or three *punctures*, and others by minute *incisions*. The plan which I have described seems to me the best, as less likely to draw blood, which might wash away the matter, and thus defeat the operator's object. The place usually selected for vaccination is the left arm, about the point of insertion of the deltoid muscle. Some persons appear to be insusceptible to the vaccine influence, while in others the protective power of the operation appears to wear out in the course of years: hence it is well to revaccinate from time to time, especially if the patient be exposed to the influence of small-pox. Bovine matter is now often employed, but if humanized virus be used, the surgeon should select a good scab from a healthy child; he should also look closely to the cleanliness of his lancet. Vaccination, like any other operation, may be followed by inflammation, or even by erysipelas, and there seems to be no doubt that on several occasions syphilis has been inoculated by careless vaccination; hence too much caution cannot be exercised as to the source of the vaccine scab, and as to the cleanliness of the instrument employed. The best age for vaccinating infants is, I think, about the end of the third month, though it may, if necessary, be done at a much earlier period.

Bloodletting.—As was mentioned in the chapter on inflammation, the surgeon is now much less often called upon to draw blood than formerly; still, every practitioner should know how to bleed, apply cups, etc., and I shall, therefore, briefly notice the principal methods of surgical depletion. These are scarification, leeching, cupping, puncturation, venesection, and arteriotomy.

Scarification.—This is done with light touches of a very sharp lancet or other knife. It is particularly useful in cases of violent conjunctivitis, when attended with great swelling or chemosis, and is often requisite to prevent destruction of the cornea in such cases.

Leeching.—There are two varieties of leech employed in practice; the American, which draws about a fluidrachm of blood, and the European, which draws at least four times as much. The part to be leeched should be well shaved and washed, and the leeches may be induced to begin their work by smearing the skin with a little warm milk or blood: according to Prof. Gross, an almost infallible plan is to dip the leech in small-beer. The leech may be applied with the fingers, or in a rolled card, or several together in a pill-box, etc. They should not be forcibly detached, but allowed to drop off of themselves, a process which may be hastened by sprinkling them with a little salt. The bleeding from the leech-bites may be encouraged by warm fomentations, or may be repressed by exposure to the air, or by pressure with dry lint. If the bleeding be excessive, it may be necessary to touch the spot with nitrate of silver or the perchloride of iron, or even to close the edges of the little wound with a delicate twisted suture. Leeches may be applied to the inside of the various mucous outlets of the body through appropriate specula.

FIG. 22.



Mechanical leech.

Cupping is a convenient mode of employing local depletion. The cup is first applied so as to invite the blood from the deeper parts to the cutaneous surface; this is done by atmospheric pressure, the air in the cup being exhausted by means of a portable air-pump, or an elastic bulb of vulcanized India-rubber; or, in the absence of these, a sufficient rarefaction may be produced by introducing the flame of a spirit-lamp for a few seconds into the interior of the cup, which is then quickly applied. The *scarificator* is provided with a number of blades, which are projected by means of a spring, and which can be set so as to cut more or less deeply, as may be required. The cup is first employed so as to produce superficial congestion; it is then removed, and the scarificator instantly applied, and as quickly as possible replaced again by the cup, into which the blood will continue to flow until the vacuum is destroyed by the internal becoming equal to the external pressure. *Dry cupping* is effected by the use of the cup without the scarificator; it may be employed as a derivative in cases in which depletion is not indicated. M. Junod has introduced an apparatus consisting of a pump, the cylinder of which is large enough to embrace a whole limb; it is made air-tight by means of a wide India-rubber band, and serves to dry-cup, as it were, the whole limb at once. Its inventor claims that it gives the benefits of general depletion without the evils attending the loss of blood, but though the instrument is certainly ingenious, I am not aware that it has been found of much practical utility. Under the name of *mechanical leeches* (Fig. 22), small instruments are sold which combine in one a cup, an exhausting apparatus, and a scarificator; they may be used when it is desired to draw blood from a very limited area, and when ordinary leeches cannot be obtained. Theobald, of Baltimore, recommends that instead of using the scarificator, a superficial "nick" should be made with a delicate knife before adjusting the cup, and that a solution of carbonate of ammonium should be applied to prevent clotting and to encourage the flow of blood.

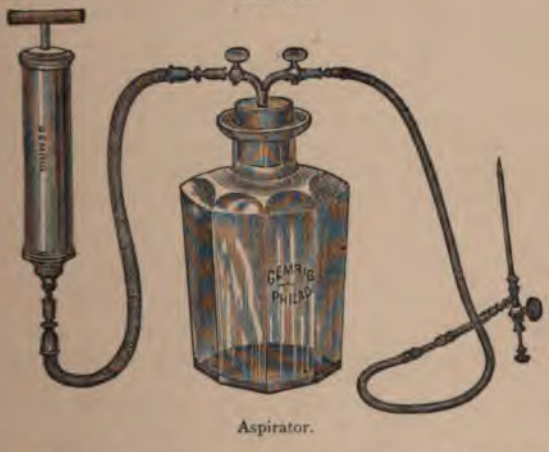
Puncturation occupies a position midway between cupping and scarification. It is best done with the point of a sharp scalpel or bistoury, and, in addition to its depletory effect, is often serviceable by relieving tension. It is principally used in cases of diffuse areolar inflammation or of erysipelas. The punctures may often be advantageously extended into limited incisions, but should not penetrate deeper than the subcutaneous tissue. A form of puncturation which is often employed by the general practitioner, is "*lancing the gums*," in cases of difficult dentition.

Venesection.—Venesection, or phlebotomy, consists, as its name implies, in the division of a vein; it is the ordinary operation by which general bleeding is effected. It may be done with a bistoury, with an ordinary thumb-lancet, or with a spring-lancet or fleam. On the very few occasions on which I have had recourse to venesection, I have employed a simple lancet, and believe it to be as convenient and perhaps safer than any other instrument. In this country, and in England, bleeding is almost always done from one of the veins at the bend of the arm, preferably the median-cephalic, as its course is further from the line of the brachial artery than that of the median-basilic. In France, bleeding is occasionally practised from the veins of the foot. To prepare a patient for bleeding, the upper arm should be surrounded with a fillet or folded handkerchief, so as to interrupt the venous but not the arterial circulation, and thus render the superficial veins full and prominent; the sitting posture is usually the best, and the patient may grasp a stick, to steady the limb, which is held out in a semisupine position. The opening in the vein should be made with an oblique puncture, the lancet cutting its way out, as it is withdrawn. The vein should be compressed *below* the point of section with the thumb of the surgeon's left hand, until the cut is completed, that a premature gush of blood may not obscure the seat of operation. If the blood flow sluggishly, the patient may be directed to alternately increase and relax his grasp of the stick which he holds, the action of the muscles of the forearm tending to increase the rapidity of the flow of blood. The bleeding will usually cease at once upon the removal of the fillet, when the wound may be lightly dressed with a small compress and a figure of 8 bandage. When bleeding is done at the foot, the *saphena vein* is opened above the inner malleolus. Sometimes the *external jugular vein* is opened in cases of apoplexy, or in children when the arm is very fat; a compress is placed over the vein immediately above the clavicle, and the vessel is opened where it crosses the sterno-cleido-mastoid muscle: the chief risk in this operation is from the admission of air into the vein.

Arteriotomy is practised on the temporal artery, or preferably on its anterior branch, above the outer angle of the eyebrow; the section should be made obliquely with a sharp bistoury, and, when enough blood has been drawn, should be made complete, so as to allow the ends of the vessel to retract. A firm compress and bandage should then be applied.

Transfusion of Blood.—This operation may be sometimes required in cases of profuse hemorrhage, as in flooding during or after labor. The chief precautions necessary are to prevent the blood from coagulating before it is injected, and to avoid introducing air into the patient's vein. Blood from a healthy bystander is drawn into a tumbler, kept at the temperature of the body by being surrounded with warm water, and, having been defibrinated by "whipping" with a glass rod, table-fork, or other convenient implement, is injected, in quantities of two fluidounces at a time, by means of an ordinary syringe (or, as advised by McDonnell, of Dublin, a glass pipette), into the median-basilic vein, which has been previously laid bare; the whole amount injected should not exceed three-quarters of a pint to a pint. By using a syringe with a sharp-pointed nozzle, the vein may be injected without having been previously exposed. Prof. Gross has devised an ingenious apparatus, by which the blood is made to flow into an exhausted receiver, and thence by a gum-elastic tube directly into the patient's vein, while M. Maisonneuve uses a simple flexible tube with a bulb provided with valves, so as to pump the blood directly from one vein into the other. Other forms of apparatus for the direct transfusion of undefibrinated blood have also been devised by Monocq, and by Roussel, of Geneva. *Arterial transfusion*, or the injection of defibrinated blood into the radial or posterior tibial artery, is recommended by Hueter as preferable to the ordinary procedure. *Saline injections* into the veins have been tried with some success in cases of cholera collapse, as has the injection of *milk* by Dr. E. M. Hodder, of Canada. Milk injections have also been employed under various circumstances, with more or less benefit, by Dr. T. G. Thomas, Dr. J. W. Howe, and Dr. Bullard, of New York; by Dr. Pepper, Dr. Hunter, and Dr. E. Wilson, of this city; by Mr. A. Meldon, of Dublin, and by other surgeons; according to Laborde, the amount injected should not exceed 200 grammes (about f℥vj.) at one sitting. Karst and Schmeltz recommend hypodermic injection of defibrinated blood as a substitute for transfusion, while Ponfick, Bizzozero, Kaczorowski, and Golgi advise similar injections into the *peritoneal cavity*, a procedure, however, which caused fatal peritonitis in a case recorded by Mossler. According to Lombroso and Atthill, the operation of transfusion is in itself not free from risk, and should not be resorted to in any case in which cardiac or pulmonary disease is present. In order to prevent the shivering which usually follows the operation, Bitot advises that quinia should be administered two days previously.

FIG. 23.



Aspirator.

Aspiration.—This is an operation which has for its object the withdrawal of fluid from a closed cavity without the admission of air. The use of a *suction trocar* has long been familiar to American surgeons through the labors of Drs. Bowditch and Wyman, of Boston, to whom its introduction is due, but the *aspirator* of Dieulafoy is a more perfect instrument, and that gentleman is justly entitled to the credit of having generalized and popularized its employment. The aspirator, as improved by Potain (Fig. 23), consists of a jar or bottle connected by flexible tubes on one side with an exhausting pump, and on the other with a delicate canula carrying a fine trocar, the apparatus being provided with stopcocks to prevent the admission of air. A vacuum having been established in the jar, the trocar and canula are introduced by a quick thrust into the part affected, when, the stopcock being opened and the trocar withdrawn, any fluid that is present is forced out (if not too thick to flow through the canula) by atmospheric pressure, and is collected in the reservoir. The most useful applications of the aspirator are, I think, to cases of hydrothorax and empyema, to cases of cold abscess connected with the hip or spine, and to cases of distended bladder from stricture or prostatic enlargement. Tachard has proposed to modify the construction of the aspirator by the introduction of the *siphon* principle.

CHAPTER V.

AMPUTATION.

It is often said, by unreflecting persons, that amputation is the opprobrium of surgery, and indeed the proposal to cut off a limb must be considered as an acknowledgment of failure on the part of the surgeon to effect a cure in any other way. But when we consider that an amputation is never done except with a view of saving life, which is more or less endangered, or to remove what is no longer of service, but a mere useless and troublesome appendage, it must be confessed that no operation can more truly deserve the name of conservative; "the humane operation" it was called by some of the older surgical writers, and it is probable that there is no other procedure in the whole range of operative surgery which has saved so many lives and obviated so much suffering as this.

The word "amputation," as now used, is generally understood to apply to the removal of a limb, though we still speak of amputating the penis, and some writers employ the term also for excision of the breast. A limb may be amputated through its bones or through its joints; the former operation is an amputation in the *continuity* of the limb, or simply an amputation; the latter, an amputation in the *contiguity*, a *disarticulation*, or an *exarticulation*.

History.—The ancients generally amputated merely through parts already dead, probably from fear of hemorrhage, to control which they had very imperfect, if any, means. It is probable, however, that Celsus, who lived about the beginning of the Christian era, was in the habit of amputating through living structures, and he also divided the bone at a higher level than the soft parts (thus anticipating in some degree the modern circular operation); he was acquainted with the use of the ligature, but whether or not he applied it to the vessels after amputation, is not quite certain. The use of a fillet to control the circulation, before amputating, is due to Archigenes, who, however, neglected the preliminary dissection of the soft parts, dividing the entire limb at the same level, and using a hot iron to arrest the bleeding. Until the latter part of the seventeenth century, there was little improvement upon these rude procedures; Paré had indeed introduced the ligature, but it was not generally adopted, and amputations were still done in essentially the same way that was prescribed by Galen and his followers. Many surgeons dreaded to cut through living parts at all, and others sought to prevent bleeding by the use of heated knives. The first tourniquet was introduced by Morel, in 1674, and a few years later an English surgeon, named Young, devised, apparently independently, a similar contrivance. These early tourniquets consisted merely of a fillet twisted with a stick, very much, in fact, like the simple apparatus which is now known as the Spanish windlass. Morel's tourniquet was subsequently improved by the celebrated Petit, and the instrument which he devised is essentially that which is used at the present day. This illustrious Frenchman, and the English Cheselden, about the same time began to operate by a double incision, cutting first the skin and subcutaneous fascia, and then the muscular tissue and bone at a higher level. Louis, on the other hand, returned to Celsus's plan, and cut down at once to the bone, which he then divided higher up; he also employed digital pressure in place of the tourniquet, believing that the latter interfered with the retraction of the muscles. The modern circular operation, a combination of Petit's and Cheselden's with that of Louis, was perfected by Benjamin Bell and Hey towards the latter part of the last century. Another form of circular amputation was practised by Alanson, who, after dividing the skin, attempted to cut the muscles into the shape of a hollow cone, by a sweep of the knife held in an oblique position. Other operators, however, did not succeed in carrying out Alanson's instructions (the almost inevitable result of his operation, according to his opponents, being a spiral incision which would terminate at a higher point than its commencement), and the "triple incision" of Hey soon became the common English operation, though Alanson's was still successfully practised by Dupuytren and others in France. In the meanwhile, amputation by means of a flap, cut from without inwards, was introduced, or, according to Velpeau, re-introduced, by Lowdham and Young in England, and shortly afterwards the formation of a flap by transfixion, by Verduin, of Amsterdam. The flap operation was subsequently improved by several other surgeons, and was finally adopted and brought into common use by the labors of Liston and Guthrie in England, of Klein and Langenbeck in Germany, and of Dupuytren, Larrey, Roux, and some others in France. All the different methods of amputating may be considered as mere varieties of these two principal modes, the flap and the circular.[1]

Conditions Requiring Amputation.—The circumstances which may render amputation necessary are manifold; they will be fully discussed in subsequent chapters, in considering the various injuries and diseases to which the human frame is liable, but I may here briefly enumerate the following, as the principal conditions which are considered to indicate the removal of a limb.

1. *When a limb is torn off* by the action of machinery, or carried away by a cannon-ball, there can be no question as to the propriety of amputation. The operation may indeed be said to have been already done by the accident which caused the injury, and all that remains for the surgeon to do is to put the wound in such a condition as to promote its healing, and insure the formation of a well-shaped stump.

2. *Mortification*, when the gangrene is more extensive than a mere superficial slough, is usually a cause for amputation. The ordinary rule, and a very sound one under most circumstances, is that the surgeon should not operate until the line of separation is well established: thus, in the form of gangrene resulting from the intensity of the inflammatory process (as after frost-bite), no operation should be done while the mortification is still extending, but the surgeon should wait until nature herself indicates that the limit of the destructive process has been reached, and may then amputate at any convenient point above the line of separation. On the other hand, in the strictly local forms of gangrene resulting from direct injury, as in compound fractures, amputa-

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[1] I would invite the reader who is interested in the history of amputation to consult my article in the *International Encyclopædia of Surgery*, vol. i., p. 552, where I have gone into the subject much more fully than I can do here.

tion should be performed as soon as the signs of mortification are unequivocally manifested; delay will commonly cause the loss of the patient, before time has been afforded for the formation of any line of demarcation. There is another class of cases, principally met with in military practice, which often demand immediate amputation. This is where gangrene follows upon an arterial lesion at a distant point, as in mortification of the foot from a wound of the femoral artery. The gangrene, in such cases, first shows itself by a change in the color of the affected part, which is at first pale and tallowy, and subsequently becomes mottled and streaked; there is at first numbness, followed by insensibility of the mortified member. In such cases, I think, with Mr. Guthrie, that while the gangrene remains limited to the toes or foot, it is right to wait, in hopes that it will not pass further; but if it manifest a tendency to spread above the ankle, amputation should be at once performed at the point where experience shows that the morbid action is likely to cease, that is, a short distance below the knee. In a similar condition of the arm, amputation should be performed at the shoulder-joint. With regard to the *dry gangrene* which attacks the extremities of old persons, it is generally advised to refrain from amputation altogether, from the fear that the morbid action would recur in the stump; and, indeed, the constitutional state of patients thus affected is usually so unfavorable for any operation, that the surgeon would naturally hesitate about proposing to amputate. It has, however, been suggested that as this senile gangrene, often at least, depends on arterial obstruction, a better chance would be afforded by amputating high up in the thigh than by any other mode of treatment; and this plan has been actually put in practice by James, of Exeter, and some others, with favorable results. It is obvious, however, that the additional risk from the operation itself would be so great, that it could only be justifiable in exceptional cases.

Amputation is sometimes required in cases of *hospital gangrene*, either after the cessation of the process, on account of the extensive destruction of parts, or even during its progress, on account of profuse hemorrhage which may occur from the opening of a large artery.

3. Amputation is sometimes necessary to remedy the evils produced by exposure to *heat or cold*. In case of frost-bite, if merely the fingers or toes are affected, it is better to allow the dead parts to be spontaneously separated, and to trim off the stump subsequently; if the mortification be more extensive, amputation may be done through the dead tissues (in order to remove a useless and offensive mass), and a second amputation be performed when the line of separation has been clearly established. In cases of burn or scald, it is proper to wait until the sloughs have spontaneously come away, and until the reparative power of nature has been fully tested, when, if it be found manifestly inadequate to the task, an amputation may be performed with the best prospects of a favorable result.

4. *Compound fractures and luxations* frequently render amputation necessary. The majority of primary amputations in civil hospitals are for these accidents, and the number of such cases which require removal of the limb is constantly becoming larger, with the multiplication of railroads and the consequent increase of travel.

5. *Lacerated and contused wounds* produced by railway or machinery accidents, by the attacks of wild animals, etc., may require amputation even though the bones have escaped injury.

6. Amputation is very often rendered necessary by *gunshot injuries.* Though so much has been done of late years to save limbs in military practice by the introduction of excision as a substitute for amputation, still the latter must always continue to be a frequent operation in the hands of the army surgeon; and, indeed, in no case is it more truly the "humane opera-

tion" than in the frightful injuries which are produced by the missiles of warfare.

7. *Various affections of the bones and joints* require removal of the limb. The number of cases of this kind which are now submitted to amputation is happily gradually becoming more limited, thanks to the introduction of excision, and to the modern improved methods of treating these affections without operation. Still, it is probable that there will always remain a certain number of cases, in which the destruction of tissue is so extensive that nothing short of amputation will avail to save life.

8. Amputation is required in certain *lesions of arteries;* thus, if the popliteal artery be ruptured, amputation is almost always indicated. Again, certain traumatic aneurisms, or spontaneous aneurisms which have become diffuse, are more safely treated by amputation than in any other way.

9. *Morbid growths* may render amputation imperative. Even non-malignant tumors may, from their size or other circumstances, call for removal of the affected limb, while malignant affections of the extremities, especially if the bones be involved, almost always demand amputation.

10. *Tetanus* has been considered a cause for amputation, and the operation has occasionally been followed by recovery from the disease. The experience of the profession has, however, shown that amputation cannot be regarded as a remedial measure under such circumstances, and few surgeons would now think it right to add the risk of a capital operation, when there is so little prospect of benefit accruing; if, however, amputation was in any case otherwise indicated, the occurrence of tetanus would be an additional reason for the performance of the operation. Amputation is not justifiable in cases of *hydrophobia*, nor in those of *poisoned wound*, from bites of serpents, etc.

11. Finally, amputation may be required for the relief of *deformity*, whether natural or acquired. These are operations of *complaisance*, and should, therefore, only be performed with the limitations specified in the chapter on operations in general.

Instruments.—The instruments required for amputation are a tourniquet or other means of controlling the circulation, knives of various shapes and sizes, saws, bone-nippers, artery forceps and tenacula, ligatures, retractors, sutures and suture needles, and scissors.

Tourniquet.—The use of the tourniquet in amputation has been reprobated by some excellent surgeons, among others by the late Mr. Guthrie. The only objections to it are that it produces a certain amount of venous congestion, and that it may interfere with the muscular retraction which is desirable in the circular operation.[1] But by taking care to elevate the limb before screwing up the tourniquet, and not to do the latter till the moment before making the incisions, the interference with the return of venous blood is so slight as to be unimportant, while the difficulty as regards the muscles can easily be obviated by retrenching the bone, if necessary, after the vessels have been secured and the tourniquet removed. In fact, the evils of this instrument are more apparent than real, while its advantages are manifest and incontestable. Guthrie and Hennen speak of compressing the artery with one hand while the amputation is done with the other, but such a course seems to me more adapted to show the skill and fearlessness of the surgeon than to promote the good of the patient; safety should never be sacrificed to brilliancy, and there can be no question that a well-applied tourniquet renders an amputation safer than the best directed manual pressure; for while the latter can only check the flow of blood through the main vessel, a tourniquet controls all the arteries at once, and it is often the smaller vessels that give the most trouble.

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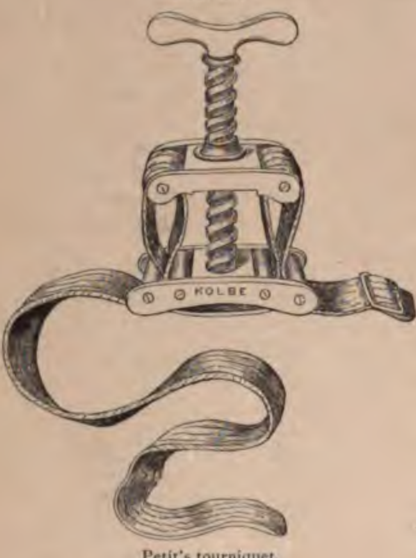
[1] It has been recently maintained that *pyæmia* is caused by the use of the tourniquet, which is supposed to cause venous thrombosis at the point of application; but all that is known of the circumstances under which pyæmia occurs discountenances such an idea.

To prevent loss of venous blood, Silvestri and Esmarch suggest that the limb should be first bound with an elastic bandage from below upwards, and then surrounded at the highest point with a band or tube of caoutchouc instead of a tourniquet; the lower bandage is then to be removed, when the operation may be performed in temporarily bloodless tissues. Esmarch's method has been largely employed by surgeons during the last few years, and with very general satisfaction; from my own experience I am prepared to recommend it as a valuable resource in cases in which the anæmic state of the patient renders it more than ordinarily important to avoid the loss of blood, or in which it is necessary that the field of operation should not be obscured by bleeding. It should not, however, be employed unnecessarily, as its use has been sometimes followed by troublesome consecutive hemorrhage, by paralysis, or even gangrene of the limb to which it has been applied, and, it is said, by embolism of the pulmonary artery and death. To prevent the oozing which follows removal of the tube, Nicaise advises compression of the wound with a sponge dipped in a 1-50 solution of carbolic acid, while Riedinger applies an induced current of electricity. Esmarch himself dresses the stump in a vertical position before removing the tube, and keeps it in that position for half an hour subsequently. My own practice is to employ both the tube and ordinary tourniquet (at a higher point), removing the former as soon as the main vessels have been secured. Ingenious modifications of Esmarch's tourniquet have been devised by Foulis, H. L. Browne, and others.

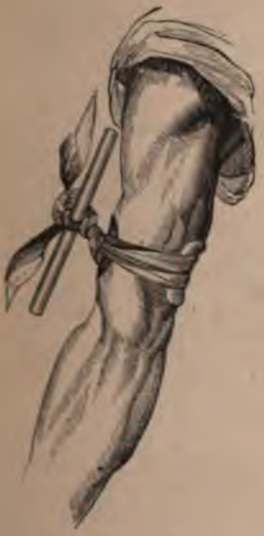
FIG. 24.



Petit's tourniquet.

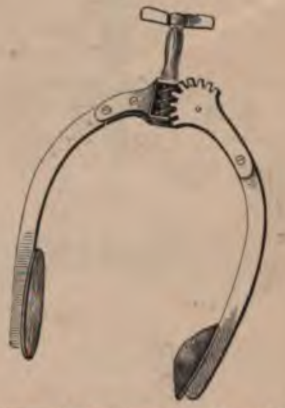
The best tourniquet for ordinary use is that known as Petit's, from having been introduced by the celebrated French surgeon of that name. It consists of two metal plates, the distance between which is regulated by a screw, with a strong linen or silk strap provided with a buckle. It is thus applied: a few turns of a roller are passed around the limb, and a firm pad or compress thus secured immediately over the main artery. Upon this pad is placed the lower plate of the tourniquet, so that the artery is held between this plate and the bone, and the strap is buckled tightly enough to keep the instrument in place. When the surgeon is ready to make his incision, the screw is turned so as to separate the plates and thus tighten the strap till the arterial circulation is entirely checked. It is often said that, provided that the compress is placed over the artery, it makes no difference to what part of the limb the tourniquet plate is applied; this is a mistake, and a moment's reflection will show that it is so: the mechanism of the tourniquet is such that it makes *direct* pressure at two points only, viz., immediately below the plate, and at a point diametrically opposite; at every other point of the circumference the pressure exerted by tightening the strap is *oblique* or gliding. Hence, unless the plate be immediately over the artery or diametrically opposite to it, the effect of turning the screw will be inevitably to push the vessel more or less to one side, and thus the circulation may not be controlled, though the instrument be applied as tightly as possible. Hence, as a rule, the tourniquet plate should go immediately over the artery: where this is not practicable, as in the case of the axilla or the popliteal space, it should be placed at a point diametrically opposite.

FIG. 25.



Spanish windlass.

FIG. 26.

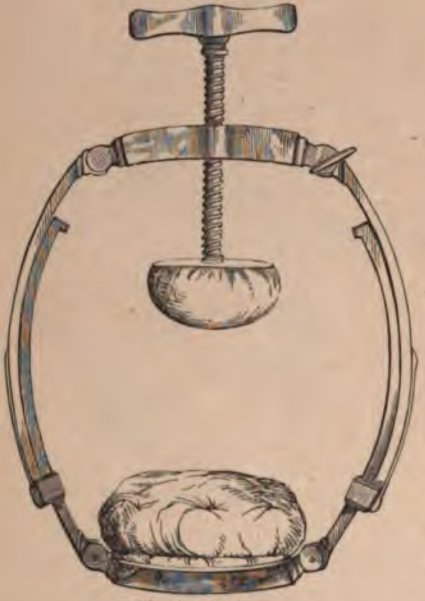


Signoroni's tourniquet: *a*, the point of counterpressure; *b*, the pad which acts directly on the vessel.

Various other forms of tourniquet have been devised, but none of them approach in value to that of Petit. The ordinary *field tourniquet*, as it is called, consists merely of a strap and buckle with a pad to go over the vessel; it is no better than the common *garrot*, or *Spanish windlass* (Fig. 25), made with a stick and handkerchief. Other forms are the *horseshoe* or *Signoroni's tourniquet* (Fig. 26), *Skey's tourniquet* (Fig. 27), and the various *artery compressors*, which are designed so as not to control the smaller vessels; however useful these may be for cases of aneurism or accidental hemorrhage, they are not, I think, as good as Petit's instrument for employment in ordinary amputations. In certain special operations, however, these are very valuable; thus hip-joint amputation is shorn of half its terrors by the use of Skey's tourniquet or Lister's aorta-compressor (Fig. 28).

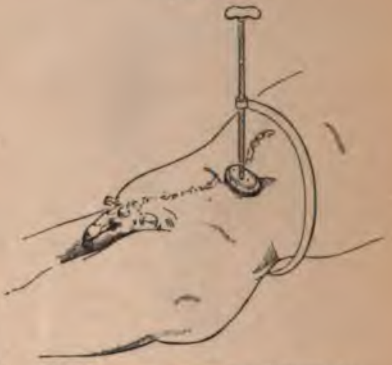
Amputating Knives.—Formerly surgeons used for the circular operation a knife with but one edge and a very heavy back, shaped somewhat like a sickle; the modern amputating knives, however, which are adapted for either the circular or the flap operation, have a sharp point, and are usually doubled-edged for an inch or two at the extremity. The length of the knife should be about one and a half times the diameter of the limb to be removed, and its breadth from three-eighths to three-quarters of an inch. Thus, a knife with a cutting edge eight or nine inches long will answer for most amputations of the thigh, while one with an edge of six or seven inches will do for smaller limbs. *Double-edged catlins* (Fig. 30) are used principally for the leg and forearm, and are convenient in freeing the interosseous space for the application of the saw; their width should not exceed three-eighths of an inch. Beside the ordinary amputating knives, the surgeon should have at hand one or two strong scalpels or bistouries (Figs. 31 and 32), about three inches long, while for smaller amputations, as of the fingers, a very slender knife with a heavy back will be found convenient. The blade of such a knife should be about two inches long and an eighth of an inch wide. The measurements which I have given are rather smaller than those usually directed, but are, I think, such as will be found satisfactory in most cases; for my own part, I much prefer a small knife to a large one, and am, indeed, in the habit of using a three-inch blade for the largest limbs, having found it quite ample even for amputation at the hip-joint. The handles of amputating knives should be of rough ebony, which is less likely to slip when bloody than either bone or ivory.

FIG. 27.



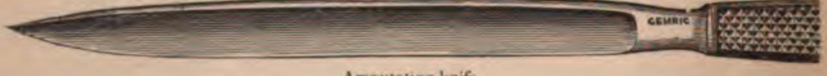
Skey's tourniquet.

FIG. 28.



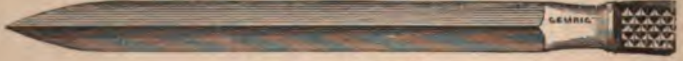
Lister's aorta-compressor. (ERICHSEN.)

FIG. 29.



Amputating knife.

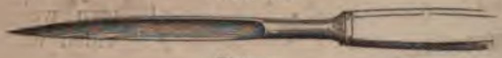
FIG. 30.



Catlin or double-edged knife.

Saws.—The amputating saw should be about ten inches long by two and a half wide; it should be strong, with a heavy back, so as to give additional firmness, and the teeth not too widely set, but just enough to prevent binding. For operations about the hand or foot, a small saw with a movable back (Fig. 33) will often be found useful.

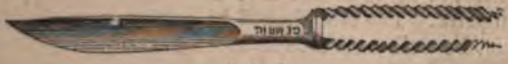
FIG. 31.



Bistoury.

Bone-nippers or *Cutting Pliers* may be used in amputating the phalanges, or for smoothing off any rough edges left by the saw in larger operations.

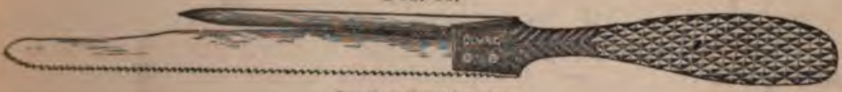
FIG. 32.



Scalpel.

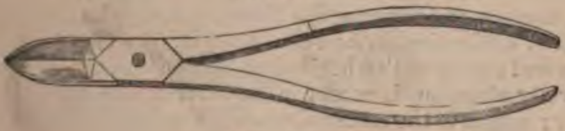
Ten to twelve inches is a good length, of which the blades should not occupy more than two inches; the blades, which are sharp, should be set at an obtuse angle with the handles, which must be very strong, and roughened to prevent the hand from slipping.

FIG. 33.



Small amputating saw.

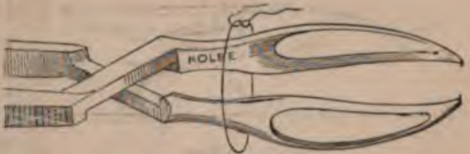
FIG. 34.



Bone-nippers.

Artery Forceps and *Tenacula* are used in taking up the vessels; the best form of forceps is essentially that invented by Liston, and known as the "bull-dog forceps;" the blades should be expanded a short distance above the points, that the ligature may easily slip over without including the instrument itself in the knot; they may be made to fasten with a catch, or, which I think is better, be provided with a spring which keeps them closed except when opened by pressure of the surgeon's fingers. The *tenaculum*, or sharp hook, must be of sufficient size and but slightly curved; it is not as good an instrument as the forceps for most cases, but is sometimes useful, especially where the parts are matted together by inflammation, and the artery cannot be separated by the forceps; sometimes it is necessary to take up a little mass of muscle or areolar tissue with *two tenacula*, and throw a ligature around the whole. Though I have never seen any harm result from this *ligature en masse*, it should not be practised when it can be avoided,

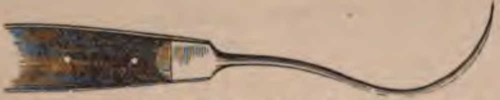
FIG. 35.



Artery forceps closing by their own spring.

and, as far as possible, each vessel should be drawn from its sheath and tied separately. Dr. Hodgen, of St. Louis, has devised an ingenious artery forceps which draws the artery from its sheath by its own weight, and is provided with a cutting slide to divide the ligature, thus enabling the surgeon to dispense with the aid of an assistant.

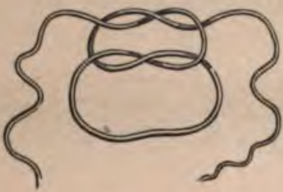
FIG. 36.



Tenaculum, or sharp hook, with which the arterial orifice is picked out.

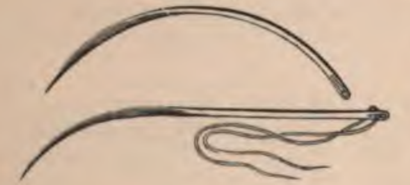
Ligatures may be made of a variety of materials, such as catgut, horsehair, iron or silver wire, or more commonly, and I think better, of fine whip-cord or strong sewing-silk. The silk should be cut into lengths of about eighteen inches, and must be well waxed to fit it for use. The ordinary skein of silk contains about six yards, and is thus sufficient for twelve ligatures. In ordinary amputations the number of vessels requiring ligature is about six or seven, but if there has been inflammation, causing enlargement of the small arteries, as many as twenty or twenty-five ligatures may be necessary. The artery having been drawn out of its sheath by the forceps or tenaculum, the ligature is thrown around it and secured by what is called the reef-knot, the peculiarities of which can be better understood from the annexed cut than from any description. It is usual after tightening the knot to cut off one end of the ligature, allowing the other to hang out at the wound. It is convenient to retain both ends of the ligature which surrounds the *main artery*, knotting them together for purposes of distinction. *Short-cut ligatures* were very highly commended by Hennen and others at the beginning of this century, but are now, I believe, generally abandoned, except in the form of the carbolized ligature of Prof. Lister; catgut is the material usually employed, but Maunder prefers carbolized silk. I have myself successfully tied the common carotid with a short-cut, carbolized, catgut ligature, and have no doubt that, when a good article is employed, it is quite safe, at least for arteries ligated in their continuity. For securing wounded arteries, however, or those divided in amputation, I still prefer the ordinary silk ligature. When catgut is employed, *three* knots instead of two should be tied, to prevent slipping. Some surgeons apply a *single* knot only to small vessels. I see no advantage in this plan, which is certainly not as safe as the use of the common reef-knot. *Acupressure* may be used to secure arteries after amputation, as may various ingenious modifications of acupressure, in which a wire is used instead of a needle; these will be considered in the chapter on wounds of arteries.

FIG. 37.



The reef-knot.

FIG. 38.



Surgical needles.

The *Retractor* consists of a piece of muslin, six to eight inches wide, one end of which is split into two tails for the thigh or arm, and into three for the leg or forearm. It is applied around the bone or bones to keep the soft tissues from being injured by the saw, and to prevent bone dust from being caught among the muscles, an occurrence which would greatly interfere with the rapidity of the healing process.

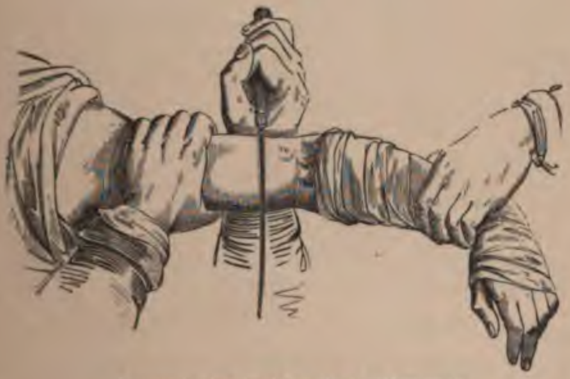
The *Sutures* may be applied with the ordinary "surgeon's needle," which for use in stumps should be large, strong, and but slightly curved; or, if the flaps be very thick, a needle, mounted in a handle and with the eye near the point, such as is used in the operation of strangulating a nævus, will be found convenient. The best material for the suture is, I think, silver, lead, or malleable iron wire, though this is a matter which may be safely left to the fancy of the operator.

Scissors are used to cut the ligatures and sutures, or to retrench any projecting nerves, tendons, or masses of fascia.

Operative Procedures.—The various modes of amputating may be considered as mere modifications of the two original forms of the operation, the circular and the flap; thus the oval operation, or that of Scoutetten, is based upon the circular, while the different methods of Vermale, Sédillot, Teale, Lee, etc., are but varieties of the flap operation.

Circular Method.—An amputation by the circular method is thus performed: Anæsthesia having been induced, and the seat of operation washed and shaved, the patient is brought to the side or the foot of the operating-table, so that the limb to be removed projects well over the edge. The circulation should be controlled by means of a tourniquet, or by manual pressure exercised by an assistant, while another assistant holds the affected limb in such a position as is convenient for the operator. The latter should stand so that his *left* hand will be *towards* the patient's trunk; thus, in amputating the *right* leg the surgeon stands on the patient's right side, while in removing the *left* leg he stands *between* the patient's limbs. The surgeon then, steadying and drawing upwards the skin with his left hand, slightly stoops, and carries his right hand, which holds a knife of sufficient length, around the patient's limb, so that the back of the knife is towards his own face. Pressing the heel of the knife well into the flesh, he makes a circular sweep around the limb, rising as he does so, and thus being enabled to complete the whole or at least the greater part of the cutaneous incision with one motion; a few light touches of the knife will now allow considerable retraction of the skin, and, if the limb be slender, this degree of retraction may be sufficient. The

FIG. 39.



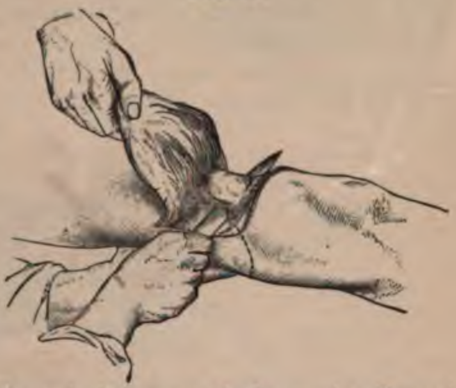
Amputation by circular method. (DRUITT.)

first incision must completely divide all the structures down to the muscles. If the skin have not retracted sufficiently, the surgeon now, either with the same knife or with an ordinary scalpel, rapidly dissects up a cuff of skin and fascia, about half as long as the limb is thick. In doing this, care must be taken to cut always *towards* the muscles; neglect of this rule will cause division of the cutaneous vessels and consequent sloughing of the part. Having done this, the operator grasps the cuff of skin with his left hand, and, with the large knife, makes another circular cut at the point of the cuff's reflection, through all the muscles and down to the bone. A wide gap is usually immediately produced by the retraction of the cut muscles; if it be not sufficient, however, the surgeon quickly separates the muscular structures from their periosteal attachments with the finger or the handle of a scalpel, pressing them back and thus cleaning the bone for the space of about two inches. If the limb contain two bones, the interosseous tissues must be divided with a double-edged knife or with the ordinary scalpel. The retractor being applied and firmly drawn upwards, the bone is now to be sawn at the highest point exposed. It is well first to divide the periosteum with a knife, and to use the saw lightly at first, so as to avoid splintering. The saw should be held vertically, and if two bones are to be divided, they should be sawn together. The assistant who holds the limb must exercise care to keep it in such a position as neither to interfere with the action of the saw nor to allow the bone to break before the section is completed. As soon as the limb is removed the surgeon secures the vessels, momentarily loosening the tourniquet, if necessary, that the gush of blood may indicate the position of the smaller arteries, and, when all bleeding is checked, proceeds to dress the stump. If any projecting spiculæ have been left by the saw, they must be removed with strong cutting pliers, and any tendons or nerves that hang out from the stump should be cut short with sharp scissors. The skin cuff is then brought together with sutures, so as to convert the circular into a linear incision, its direction being horizontal, vertical, or oblique, according to the fancy of the operator. It is well to apply a bandage with circular turns from above downwards, to the stump, so as to prevent spasm or subsequent muscular retraction. Sometimes great difficulty is experienced in turning up the skin cuff, from the conical shape of the limb. In such cases the surgeon may slit the cuff at one or both sides, thus converting the procedure into a modified flap operation.

Flap Method.—Amputation by the flap method is susceptible of an almost infinite number of variations. Thus there may be only one flap, more commonly two, or even a larger number. The flaps may be cut antero-posteriorly, laterally, or obliquely; they may be made by transfixing the limb and cutting outwards, or may be shaped from without inwards, or one may be made by transfixion and the other from without. They may include the whole thickness of tissue down to the bone, or merely the skin and superficial fascia, or they may embrace the superficial muscles, while the deeper layer is divided circularly (Sédillot). Finally, they may have a curved outline, or they may be rectangular.

In practising the ordinary double-flap amputation, the surgeon stands as for the circular amputation, and grasping and slightly lifting the tissue which is to form the flap, enters the point of the long knife at the side nearest himself; then pushing it across and around the bone with a decided but cautious motion, and slightly raising the handle when the bone is passed, he brings the point out diametrically opposite its place of entrance. Holding the blade in the axis of the limb, he then shapes his flap by cutting at first downwards, with a rapid sawing motion, and then obliquely forwards. Turning up the flap, he re-enters the knife at the same point as before, carries it on the other side of the bone, brings it out with the same precautions as at first, and cuts his second flap. He then applies the retractor, makes a circular sweep to divide any remaining fibres, and saws the bone as in the circular operation. In many situations, as in the front of the leg where the bone is superficial, it is impossible to make a flap by transfixion, and in any part, if the limb be large, the flap thus made is unwieldy, the skin retracting more than the muscles, which project and interfere with the closure of the wound. Hence it is often better to make at least one flap by cutting from without inwards, dividing the skin and superficial fascia by the first incision, and the muscles by a second, at a higher point.

FIG. 40.



Amputation by antero-posterior flap operation. (BRYANT.)

In view of the wasting and gradual disappearance of muscular tissue, which always takes place in a stump, some surgeons think to save time and trouble by making flaps of skin only; but, apart from the danger of sloughing, which always attends these long skin flaps, unsupported by muscle, the resulting stump is not so serviceable, for though the true muscular structure does indeed disappear, the fibrous sheath of the muscle remains, becoming condensed into a thick pad which forms a very necessary covering for the bone.

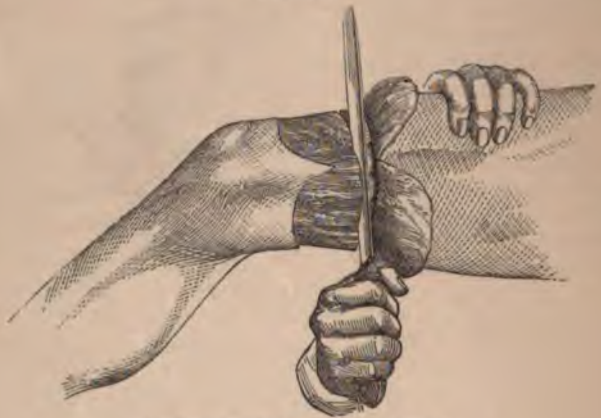
In making antero-posterior flaps by transfixion, the anterior one should be cut first; if the flaps are shaped from without inwards, the lower should be formed first, as otherwise the blood from the first incision would obscure the line of the second. In making lateral flaps, the outer should be the first cut, and, generally, it may be stated that that flap should be first formed which does *not* contain the principal artery.

I have advised that for the flap as well as for the circular operation the surgeon should stand with his *left* hand towards the patient's trunk. Many authors, however, including Mr. Liston and Mr. Erichsen, direct that exactly the opposite posture should be assumed, with the left hand on the part to be removed. I have no doubt that every one will find that position most convenient to which he is most accustomed; but consider that which I have recommended to be the best, as enabling the operator to have more control over hemorrhage, in case of sudden slipping of the tourniquet or relaxation of his assistant's grasp.

Oval and Elliptical Methods.—The oval amputation in its simplest form may be considered as a circular operation, in which the cuff of skin has been slit at one side, and the angles rounded off. In this form it is used for disarticulation at the metacarpo-phalangeal joints, and, with a slight modification, constitutes Larrey's well-known method of amputating at the shoulder-joint. Another form of the oval operation, which in this case should rather be called elliptical, is particularly adapted to the knee and elbow-joints, though it is applied by the French to other parts as well. The incision in this form of amputation constitutes a perfect ellipse, coming below the joint on the front or outside of the limb; the resulting flap is folded upon itself, making a curved cicatrix and furnishing an excellent covering for the stump.

Modified Circular Operation.—This plan seems to have been suggested by Mr. Liston, and was afterwards improved and largely employed by Mr. Syme. It may be regarded as the ordinary circular operation, with the skin cuff slit on both sides and the angles trimmed off. It is done by cutting with a suitable knife two short curved skin-flaps, and dividing the muscles with a circular sweep of the instrument: it is particularly adapted to amputations through very muscular limbs.

FIG. 41.

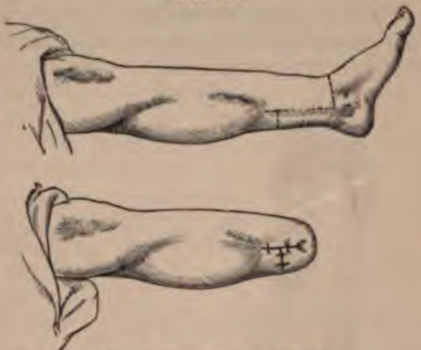


Modified circular amputation. (SKEY.)

Teale's Method by Rectangular Flaps.—This operation, which was introduced and systematized by Mr. Teale, of Leeds, about twenty-five years ago, undoubtedly furnishes a most elegant and serviceable stump. There are two flaps of unequal length, the shorter always containing the main vessel or vessels of the limb. The flaps are of equal width, but while one has a length of *half the circumference* of the limb at the point where the saw is to be applied, the other is but *one-quarter as long* (*i. e., one-eighth* of the circumference). The lines of the flaps should be marked with ink or crayon before beginning the operation, as otherwise, especially in dealing with a conical limb, it is almost impossible to cut the long flap of the requisite rectangular shape. Both flaps are to embrace all the tissues down to the bone, and the long flap, which is in shape a perfect square, is, after sawing the bone, folded on itself, and attached by points of suture to the short flap. The advantages of this mode of amputating are that it secures a good cushion of soft parts over the end of the stump, and that the resulting cicatrix is entirely withdrawn from the line of pressure, in adapting an artificial limb: its disadvantage is that, if used upon a muscular limb, it requires the bone to be divided at a much higher point than would otherwise be necessary, and thus, in the case of the thigh at least, adds much to the gravity of the operation. Hence it has been suggested by Prof. Lister to alter the relative dimensions of the flaps, making the longer of just sufficient size to bring the cicatrix out of the line of pressure, while its diminished length is compensated for by increasing that of the short flap. I have myself employed this modified form of Teale's operation (keeping, however, the rectangular shape of the flaps), and have found it to answer quite as well as the original.

Relative Merits of the different Methods.—I do not purpose to enter into a discussion of the supposed advantages of one method of amputating over another, believing that excellent results may be obtained by any of these plans, and that the difference in the results of amputation in the hands of various operators is not so much due to the particular procedure employed, as to the judgment displayed in selecting cases for operation, and the care manifested in conducting the after-treatment. When I began to operate, I practised one or other form of the flap amputation almost exclusively, having a prejudice against the circular method, which is certainly less easy of execution and less brilliant than the other. During late years, however, my views upon this point have undergone some modification, and I now prefer the circular operation in certain localities. The surgeon should not, I think, confine himself to any one method exclusively, but should vary his mode of operating according to the exigencies of the particular case. If any general rule were to be given, I should say that the circular incision or Teale's method gives the best stumps in the forearm, the modified circular in the upper-arm and the upper part of the thigh, the single or double flap operation immediately above or below the knee, the circular or lateral-flap in the lower part of the leg, and the oval operation at the joints. The points to be considered in choosing an operation for any particular part of the body will be referred to in discussing the special amputations.

FIG. 42.



Teale's amputation. (BRYANT.)

Simultaneous, Synchronous, or Consecutive Amputation.—It occasionally becomes necessary, in cases of severe injury, to remove two or more limbs by primary amputation at the same time. Sometimes this has been done by two surgeons operating simultaneously, but it is better for one to do both amputations consecutively, beginning with the limb that is most severely hurt. Though the prognosis of these double amputations is always unfavorable, yet recoveries have followed with sufficient frequency to justify the surgeon in having recourse to the knife, when the condition of the patient will at all permit it. If the hemorrhage can be effectually controlled by tourniquets, it is better to remove both limbs before stopping to take up any vessels; though if the first amputation have produced much depression, it may be necessary to pause and administer restoratives before proceeding to the second. One of the most remarkable cases of synchronous amputation[1] on record is that done by Dr. Koehler, of Schuylkill Haven, Pennsylvania, who thus removed both legs and one arm from a boy of thirteen, the lad making an excellent recovery in spite of this severe mutilation. I have myself successfully resorted to synchronous amputation of the right hip-joint and left leg (Fig. 43), for a railway injury occurring in a lad of fifteen.

Dressing of the Stump.—After an amputation, the stump should not be dressed until all hemorrhage has ceased. Sometimes after all the recognizable vessels have been secured, a troublesome oozing continues from the face of the stump; this is usually venous bleeding, and will commonly cease of itself when the tourniquet is removed. If it do not, it may probably be checked by elevating the stump, and pouring over it a stream of cold water, or of diluted alcohol.[1] Bleeding from the medullary cavity of the sawn bone may be stopped by inserting a piece of dry lint, a plug of wood, or better, a pellet of previously softened white wax; the latter has the advantage of being perfectly unirritating, so that, if necessary, it may be allowed to remain when the flaps are brought together. A plug of catgut is preferred by Riedinger. If the surgeon have any reason to fear consecutive hemorrhage, the stump should not be finally closed for some hours, or until complete reaction has occurred, a piece of lint, dipped in olive oil, being meanwhile laid between the flaps (as suggested by Mr. Butcher), to prevent their adhering, and the sutures left loose until the surgeon is ready for the final dressing. The ligatures are to be brought out at one or both angles of the wound, as may be most convenient; it has been suggested to bring each one through the face of the flap by a separate puncture, but such a plan seems to me more adapted to delay union by producing increased irritation, than to promote quick healing. The edges of the amputation wound are to be brought together, *not too tightly*, by the use of sutures, and the flaps, if heavy, may be additionally supported by the use of adhesive strips. It is a great mistake to hermetically seal a stump; there is always a considerable flow of serum for some hours after an amputation, and if this fluid be not allowed to escape from the stump, it inevitably decomposes and produces irritation. Various modes of dressing a stump have been employed; Mr. Teale directed what has been called dry-dressing, which was, in fact, no dressing at all, the stump being simply laid on a pillow (which was covered with gutta-percha cloth), and protected by throwing over it a piece of thin gauze. Sir J. Y. Simpson highly commended the exposure of both amputation and other wounds to the air, calling the scab produced by this exposure a "natural wound lute." Dr. J. R. Wood, of New York, goes still further, treating stumps by what he calls the "open method," without either sutures, plasters, or dressings. MM. Guérin and Maisonneuve have, on the other hand, devised ways of treating stumps in exhausted receivers, giving their respective plans the

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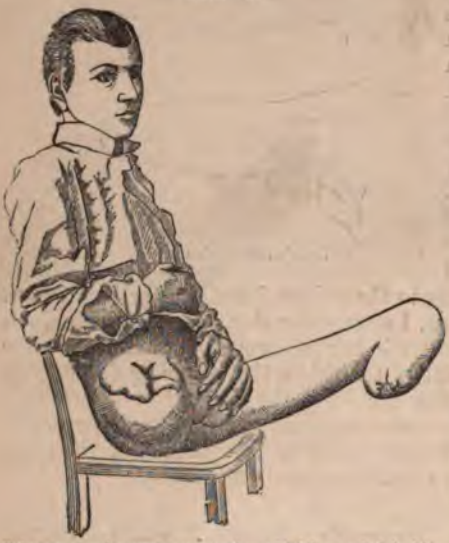
[1] *Quadruple amputations*, or amputations of both upper and both lower extremities, have been successfully performed by Dr. Alfred Muller, Acting Assistant Surgeon, U. S. A., Dr. Begg, M. Champenois, and other surgeons, but it does not appear that the operations in any of the eight cases to which I have references, were synchronous.

FIG. 43.



Primary synchronous amputation of left leg and right hip-joint. (From a patient in the University Hospital.)

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[1] Under the name of *parenchymatous hemorrhage*, Dr. Lidell has described (following Stromeyer) a general capillary oozing, due to dilatation of the capillary vessels, either by the inflammatory process, or as the result of obstruction of the principal veins from thrombosis. The treatment recommended in the former case consists in the application of the persulphate or perchloride of iron, hot water, or the actual cautery; in the latter, ligation of the main artery or amputation at a higher point (*U. S. San. Commission Surgical Memoirs*, vol. i., pp. 237–250).

euphonious titles of "pneumatic occlusion" and "pneumatic aspiration." A. Guérin has recently recommended the employment of cotton, as a means of excluding deleterious germs, which are supposed to exist in the atmosphere. The "antiseptic method" of Prof. Lister has been quite extensively used in the treatment of stumps, and, I doubt not, answers a very good purpose. The dressing which I myself prefer, consists of a piece of sheet lint soaked in pure laudanum, covered with oiled silk or waxed paper, and secured in place with a light recurrent bandage; the local use of the narcotic is soothing to the patient, while the styptic and antiseptic properties of the alcoholic menstruum are often useful. In military practice cold water is the most convenient application to a recent stump, and, if not too long continued, answers very well. Whatever dressing is used, the stump should not be disturbed for forty-eight or seventy-two hours, by which time suppuration will usually have begun; the wound may then be dressed with diluted alcohol, with lime-water, or with any other substance that the condition of the part may indicate.

If organic sutures have been used, they should be removed about the third or fourth day; metallic sutures may remain longer, and need not usually be taken away until firm union has occurred, and until they are therefore of no further use. The ligatures may be expected to drop from the smaller vessels after the fifth or sixth day; from the larger arteries after the tenth or twelfth. The ligatures should always be allowed to *drop* of themselves; but when the time usually requisite for their separation has elapsed, the surgeon may at each dressing gently *feel* them, to ascertain if they are loose. If acupressure has been employed, the pins or needles from the smaller vessels may be removed on the second day; that on the main artery on the third or fourth, according to the extent of the clot formed, which may be estimated by the point at which pulsation in the flap ceases.

Structure of a Stump.—A stump continues to undergo changes in its structure for a long while after cicatrization is completed; the muscular substance wastes, and the muscles and tendons become converted into a dense fibro-cellular mass, which surrounds the bone; the bone itself is rounded off, and its medullary cavity filled up; the vessels are obliterated up to the points at which the first branches are given off, firm fibrous cords marking their place below; the nerves[1] become thickened and bulbous at their extremities, these bulbs being composed of fibro-cellular tissue, with numerous nerve fibrils interspersed. Upon the firmness and painlessness of a stump, depend greatly the facility and comfort with which an artificial limb can be worn. In the case of the upper extremity, there is comparatively little difficulty, and very ingenious and serviceable arms and hands are now supplied by the manufacturers. In the lower extremity, it is found that very few stumps will bear the entire pressure produced by the weight of the body in walking upon an artificial limb, and hence a portion at least of the pressure should be taken off by giving the apparatus additional bearings upon the neighboring bony prominences; thus for an amputation of the leg, the artificial limb should bear upon the knee, while in the case of a thigh stump, the tuber ischii and hip should receive the principal pressure.

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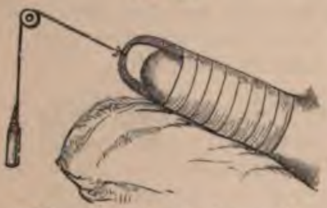
[1] Localized atrophy of that half of the spinal cord which corresponds to the side on which amputation has been performed has been observed by Dickinson, Clarke, and Vulpian, and is, according to the latter author, directly due to the section of the nerves of the amputated limb. Similar changes have been observed by S. G. Webber, Genzmer, Dickson, Leyden, and Dreschfeld, while Chuquet and Luys have observed cerebral atrophy on the opposite side. Bèrard, many years ago, noted atrophy of the anterior roots of the spinal nerves corresponding to the amputated part.

Affections of Stumps.—Any one of the constituents of a stump may give trouble after an amputation, and the treatment of the morbid conditions of a stump is a very important matter for the surgeon's consideration.

1. *Spasm of the muscles* often occurs and causes much suffering a few hours after an amputation; it is best treated by the use of a moderately firm bandage around the part, and by the exhibition of anodynes. Dr. Mitchell and Dr. H. C. Wood have recorded cases in which persistent and intractable *choreic spasms* occurred at a later period.

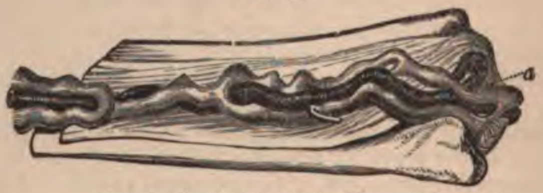
2. *Undue retraction of the muscles* may occur and continue for days or even weeks after an amputation, interfering with cicatrization, and giving rise to a very intractable form of ulceration, or even going so far as to produce what is called a *conical or sugar-loaf* stump. The *mechanical ulcer*, as it is called, of stumps, requires the limb to be firmly bandaged with circular and reversed turns from above downwards; the action of the muscles is thus restrained, and the soft parts coaxed downwards, as it were, and enabled to heal while the tension is removed; or extension may be applied by means of a weight and broad strips of adhesive plaster, or a light splint, as in Fig. 44. There is, however, another cause for the production of conical stumps, in cases of young persons, apart from muscular retraction or wasting by suppuration; this is a positive elongation of the bone by growth subsequent to amputation. This is chiefly seen in the leg and upper arm, and the occurrence in these situations, rather than in the thigh or forearm, is easily accounted for by remembering the physiological fact, that the upper extremity grows principally from the upper epiphysis of the humerus and the lower epiphyses of the radius and ulna, while the lower extremity grows chiefly from the lower epiphysis of the femur and the upper part of the tibia. Hence, in amputations of the thigh or forearm, the principal source of growth for that particular member is taken away; while in the upper arm or leg, it remains, and is liable to cause subsequent protrusion of the bone through the soft parts. To whatever cause the existence of a conical stump be traceable, if the stump will not heal over the bone, or if, though a cicatrix form, it be thin, tender, and constantly liable to re-ulcerate, there is but one remedy, which is to resect the projecting end of the bone; this is fortunately a proceeding which is attended with but little risk, and its results are usually satisfactory.

FIG. 44.



Thigh stump, with splint for extension. (BRYANT.)

FIG. 45.



Aneurismal varix in a stump. (ERICHSEN.)

3. *Erysipelas* or *diffuse cellular inflammation* may attack the tissues of a stump; and either constitutes, under these circumstances, a very serious affection. All sutures should be at once removed, soothing and emollient

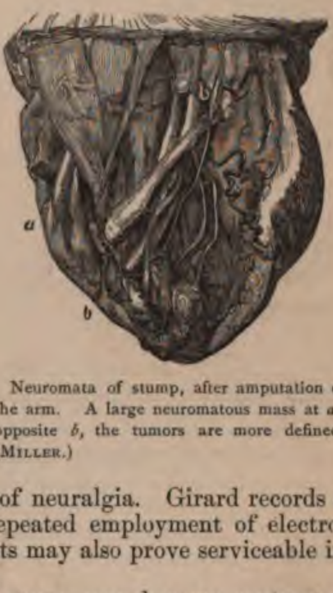
dressings applied, and the general treatment adopted which will be described when speaking of those diseases.

4. *Secondary hemorrhage* may occur from the vessels of a stump, at any time before complete cicatrization has taken place. If it be not profuse, elevating the part, and the application of cold, or pressure, will often be sufficient to check the bleeding; if it continue, or recur, more decided measures must be adopted, which will be discussed in the chapter on wounds of arteries.

5. *Aneurismal enlargement* of the arteries of a stump occasionally occurs; the annexed wood-cut (Fig. 45), from Mr. Erichsen's *Surgery*, illustrates a case of aneurismal varix occurring after amputation through the ankle-joint.

6. *Neuroma*, or painful enlargement of the nerves of a stump, occasionally occurs. This distressing affection is, according to Mitchell, not due to the bulbous enlargement of the nerve (which is, indeed, met with in all stumps), but to the existence of neuritis,[1] or of a sclerotic condition resulting from inflammatory changes. Should the pain evidently arise from any distinct tumor connected with a nerve, it would be proper to cut down and remove it; under other circumstances the nerve may be stretched, or a portion excised at a higher point, or re-amputation performed, though unfortunately these are by no means infallible remedies; Dr. Nott gives a case in which a man submitted to three re-amputations and three nerve excisions for neuralgia of a stump, deriving at last only questionable benefit from this large experience in operative surgery. As a palliative remedy, the application to the stump of the strong tincture of the root of aconite is occasionally useful, or hypodermic injections of morphia may be used, as in other cases of neuralgia. Girard records a case in which relief was obtained by the repeated employment of electro-puncture. Leeches, ice, and counter-irritants may also prove serviceable in some instances.

FIG. 46.



Neuromata of stump, after amputation of the arm. A large neuromatous mass at *a*; opposite *b*, the tumors are more defined. (MILLER.)

7. *The tendons* in the neighborhood of a stump may become contracted and cause troublesome deformity; thus, after Chopart's amputation on the foot, the natural arch of that organ being destroyed, the tendo Achillis may be drawn up by the powerful muscles of the calf, and a painful form of club-foot result, the cicatrix being thrown against the ground in walking. The occurrence of this condition should, if possible, be prevented by the use of appropriate splints and bandages, and it may be sometimes even necessary to resort to tenotomy when milder measures will not suffice.

8. *Periostitis*, *Osteitis*, and *Osteo-myelitis*, one or all, may occur in a stump, and may defeat the surgeon's anticipations of a successful issue. If acute and extensive, these affections endanger life, and, especially in the femur, are apt to terminate fatally. The diffuse suppurative form of osteo-myelitis is especially apt to occur when the division of the bone has exposed the

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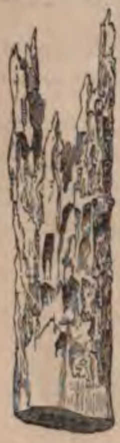
[1] Ascending neuritis in a stump may, according to Nepveu, lead to paralysis and contraction of other parts, by causing myelitis, which may be either unilateral or transverse.

medullary cavity, and is almost sure to end in pyæmia and death; the best mode of treatment is re-amputation at the nearest joint, which is of course an almost desperate remedy, though König effected a cure in one case by scooping out the diseased medulla and stuffing the cavity with cotton saturated with a strong solution of chloride of zinc. Less violent forms of bone inflammation result in the occurrence of—

FIG. 47.



Necrosis of the bone after amputation. (LISTON.)

9. *Necrosis*, which may likewise be produced by injury from the saw, at the time of operation. The treatment of this condition consists pretty much in waiting for the natural separation of the necrosed part, which will then be *exfoliated* as a ring of dead bone, or as a long conical sequestrum (Fig. 47). I do not believe that anything is to be gained, under these circumstances, by interference with the slow but safe processes of nature; in the case, however, of the occurrence of acute necrosis, as it is sometimes called, or more properly *diffuse subperiosteal suppuration*, it may be necessary to amputate to save life, just as it would be under the same circumstances occurring elsewere than in a stump.

10. *Caries* may occur in the bone of a stump. I have seen benefit result in such cases from the injection of the preparation introduced by M. Notta, under the name of *Liqueur de Villate*. (℞. Zinci sulphatis, Cupri sulphatis, āā gr. xv.; Liq. plumbi subacetatis f℥ss; Acid. acet. dilut. vel Aceti alb. f℥iijss. M.)

11. Finally, an adventitious *bursa* may be formed over the bone of a stump, as in any other part subjected to much pressure. If this bursa become painful, the artificial limb should be altered so as to relieve it from pressure; if this be not sufficient, an effort may be made to obliterate the bursa by the introduction of the tincture of iodine or by establishing a small seton, or the bursa itself may be excised.

Mortality after Amputation.—The results of amputation depend on a variety of conditions. Some of these are common to this as to other serious operations, and have mostly been sufficiently referred to in the chapter on operations in general; the most important circumstances coming into this category are the age and the constitutional state of the patient, and the hygienic conditions to which he is subjected before, at the time of, and after the amputation. The relation between the *barometric condition* of the atmosphere and the mortality after amputation has been particularly investigated by Dr. Addinell Hewson. He finds that, at the Pennsylvania Hospital, the mortality varied from 11 per cent. with an ascending, to 20 per cent. with a stationary, and 28 per cent. with a falling barometer. While the column of mercury was rising, the average duration of life, in fatal cases, was only seven days, but was thirteen while the column was falling; and of all the cases that died within three days, over 75 per cent. proved fatal while the barometer was rising. "Surely," he adds, "these figures need no commentary as to how well they sustain the idea that the results of operations are materially influenced by the weather, and that the risks from shock are increased by opposite conditions" (*Penna. Hosp. Reports*, vol. ii., p. 34).

Recent statistics as to the influence of the *age* of patients upon the results of amputation have been collected by several surgeons, including Dr. T. G. Morton, Mr. Golding-Bird, Dr. Gorman, and Mr. Holmes, the latter of whom finds that "the risk of amputation is constantly rising throughout life, and at any given period after thirty years of age the risk is more than twice as great as it was at the same period after birth."

Besides the circumstances which have been referred to, there are others which affect the result of amputation, and which are peculiar to this as distinguished from other operations; these are now to be considered.

1. *Locality.*—The part of the body at which an amputation is performed exercises an important influence on the result; amputations of the lower extremity are more apt to prove fatal than those of the upper, and in the same limb the rate of mortality varies directly with the proximity to the trunk of the point of amputation.

These facts will appear from the following table, which I have prepared from the published statistics of British[1] and American[2] hospitals, and from those of our late war,[3] together with those of the war in the Crimea.[4]

Table showing Mortality of Amputations in Different Parts of the Body, for Traumatic Causes, in Civil and in Military Practice.

	Civil Hospitals.			American and Crimean Wars.			Aggregates.		
Locality.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent	Cases.	Deaths.	Mortality, per cent.
Thigh, .	367	197	53.68	3516	2715	77.22	3883	2912	74.99
Leg, . .	633	264	41 71	3278	1089	33.22	3911	1353	34.59
Arm, . .	332	86	25.90	6415	1805	28.14	6747	1891	28.03
Forearm,	298	41	13.76	2181	444	20.35	2479	485	19.56
Totals, .	1630	588	36 07	15,390	6053	48.85	17,020	6641	39.02

In amputations of the thigh, the mortality varies according as the operation is done in the upper, lower, or middle third. The following are the percentages given respectively by Legouest and Macleod, both referring to the British army in the Crimea, though for different periods of the war.

	Legouest.	Macleod.
Upper third, ...	87.2	86.8
Middle third, ...	58.5	55.3
Lower third, ...	55.0	50.0

2. The *part of the bone* which is divided in an amputation influences the result, the mortality being greater when the medullary cavity is opened than when only the cancellous structure at the end of the bone is involved. This appears to be owing to the greater probability of pyæmia supervening under the former circumstances. Of 295 cases of amputation which were followed by pyæmia during our late war, 155, or 52.5 per cent., were through the shaft of the femur (*Circular No.* 6, S. G. O., 1865, p. 43).

3. The *nature of the affection* for which an amputation is done, exercises a most important influence upon the result: thus amputations for injury are

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[1] St. George's Hosp. Reports, vol. viii.; Med.-Chir. Trans., vol. xlvii.; and Guy's Hosp. Reports, 3d s., vol. xxi.

[2] Am. Journ. Med. Sciences, April, 1875; Boston City Hosp. Reports, 2d s., 1877; and Boston Med. and Surg. Journ., 1871.

[3] Circular No. 6, S. G. O., Washington, 1865, and Surgical History of the War.

[4] Legouest, Chirurgie d'Armée, pp. 722–735.

much more fatal than those for disease; the removal of a limb for cancer is more likely to be followed by death than the same operation if practised for caries or a chronic joint affection; while amputations of *complaisance* or *expediency* (as for deformity) are less successful than those for other pathological conditions. The relative mortality of amputations for injury and disease, as exhibited by the published reports of hospital practice in various countries, is shown in the following table:

Amputations for Injury.				For Disease or Deformity.			Totals.		
Place of observation.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.
French Hospitals,[1]	652	378	57.98	947	406	42.87	1599	784	49.03
English Hospitals,[2]	610	250	40.98	1107	251	22.67	1717	501	29.18
American Hospitals,[3]	1252	400	31.95	629	117	18.60	1881	517	27.49
Aggregates, . . .	2514	1028	40.89	2683	774	28.85	5197	1802	34.67

The mortality which attends amputations of expediency has been particularly investigated by Mr. Golding-Bird, of Guy's Hospital, who finds it to be (in that institution) 26.8 per cent., as compared with a death-rate of 21.1 per cent. for other pathological causes; or, if the lower extremity alone be considered, the former class of cases gives a mortality of 42.8 per cent., and the latter of 29.1 per cent.

4. In amputations of the same category, the *time* at which the operation is done exercises an important influence over the result; thus, amputations for *acute* affections of the bones or joints are much more fatal than those of chronic diseases of the same parts. Amputations for traumatic causes are usually divided by surgical writers into *primary* or *immediate*, and *secondary* or *consecutive*. Primary amputations are such as are done before the development of inflammation, a period rarely exceeding twenty-four hours, though, if there have been much shock, it may reach to forty-eight hours, or possibly still longer, from the time at which the injury was received. A better classification is that of military writers who make a third class, the *intermediate*, which embraces all operations done during the existence of active inflammation, reserving the term secondary for such as are done after the subsidence of inflammatory symptoms, and when the condition of the part somewhat assimilates the case to one of amputation for chronic disease. Verneuil applies to these three divisions the terms *antepyretic*, *intrapyretic*, and *metapyretic*, respectively.

It is now, I believe, universally acknowledged among military surgeons that primary amputations (except of the hip-joint and the upper part of the thigh) do better than others; of those which are not primary, the secondary do better than the intermediate. It is, however, commonly said that in *civil* practice secondary amputations are more successful than primary, and this difference has been accounted for by the different hygienic circumstances by which soldiers and civilians are respectively surrounded. I believe that the usual statement upon this point is erroneous, and that a careful collation of statistics will show that in both civil and military practice, primary amputations are followed by better results than others. To illustrate this point, I have drawn up the table which follows, and in which the results of primary amputations, or those performed in the pre-inflammatory stage, are compared with those of all others for traumatic causes.

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[1] Malgaigne (Arch. Gén., Avril et Mai, 1842), and Trélat (Legouest, op. citat., p. 707).

[2] St. George's Hosp. Reports, vol. viii.; Med.-Chir. Trans., vol. xlvii.; Guy's Hosp. Reports, 3d s., vol. xxi.

[3] Am. Journ. Med. Sciences, April, 1875; Boston City Hosp. Reports, 2d s., 1877, and Boston Med. and Surg. Journ., 1871.

PRIMARY.			SECONDARY AND INTERMEDIATE.			OBSERVATIONS FROM CIVIL HOSPITALS.	
Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.	Reporter.	Reference.
49	34	69.4	20	13	65.0	Malgaigne.	Arch. de Méd., 1842. [vol. xvii.
64	15	23.4	28	10	35.7	James.	Trans. Prov. Med. & Surg. Assoc.,
18	7	38.9	5	2	40.0	South.	Notes to Chelius, vol. iii.
74	39	52.7	43	26	60.5	Laurie.	James, loc. cit.
169	62	36.7	53	37	69.8	Steele.	Ibid. [367.
180	60	33.3	87	61	70.1	McGhie.	Macleod, Surg. of Crimean War, p.
50	9	18.0	6	1	16.7	Hussey.	Ibid. [p. 81.
48	18	37.5	43	19	44.2	Erichsen.	Science and Art of Surgery, vol. i.,
40	8	20.0	9	6	66.7	Parker.	Cooper's Surg. Dict., vol. i., p. 121.
71	23	32.4	10	3	30.0	Fenwick.	Ibid.
93	15	16.1	37	13	35.1	Callender.	Med.-Chir. Trans., vol. xlvii.
144	60	41.6	42	17	40.4	Spence.	Lectures on Surgery, vol. ii., etc.
37	12	32.4	24	7	29.1	Buel.	Am. Journ. Med. Sci., 1848.
29	14	48.3	13	7	53.8	Lente.	Trans. Am. Med. Assoc., vol. iv.
656	164	25.0	118	45	38.1	Morton.	Surg. in the Penna. Hosp., 1880.
241	84	34.9	87	32	36.8	Chadwick.	Bost. Med. and Surg. Journ., 1871.
164	68	41.5	50	21	42.0	Gorman.	Bost. City Hosp. Rep., 1877.
240	104	43.3	94	53	56.4	Golding-Bird.	Guy's Hosp. Rep., 3d s., vol. xxi.
75	31	41.3	5	4	80.0	Varick.	Am. Journ. Med. Sci., 1881.
55	16	29.0	17	8	47.0	Ashhurst.	Internat. Encycl. of Surg., vol. i.
2497	843	33.7	791	385	48.6	Aggregates.	

It will be perceived from this table that, except in the reports of Malgaigne, Hussey, Fenwick, Spence, and Buel, the primary amputations have been invariably less fatal than the others; while in the aggregate, the mortality of the primary has been about 1 in 3, compared with a death-rate of 1 in 2 for the intermediate and secondary operations. I do not know of any extended statistics to show the relative mortality of the two latter classes of amputations in civil practice; but as far as they have been distinguished by writers on the subject, the general impression has been confirmed that intermediate operations are very fatal, and that those done when the inflammatory symptoms have subsided are comparatively successful.

These numerical considerations, however, though interesting, scarcely give a fair view of the whole merits of the case; for primary operations are naturally done in cases where there is no possibility of saving the limb, while consecutive amputations are, on the other hand, performed in cases which are to a certain extent selected. Moreover, the least hopeful cases among any large number are eliminated by death before the secondary period is reached, so that even if the numerical chances of consecutive operations were the best, it would by no means be proved that more lives would not have been saved had more limbs been primarily amputated.

The practical rule to be derived from what has been said, is that, in any case of injury in which it is evident that an amputation will be needed, the operation should be done as soon as possible after reaction has occurred, and before the injured part has become inflamed; but if by any chance this golden opportunity has been lost, and the intermediate or inflammatory stage has come on, operative interference must, if possible, be postponed until the inflammation has measurably subsided, and till the patient's condition has become assimilated to that of a case of chronic disease rather than of traumatic lesion.

To complete this part of the subject, I quote from Dr. Macleod (*Notes on the Surgery of the Crimean War*, p. 367), the following summary of the results of primary and secondary amputations in military practice.

Primary operations, 1047 cases, 374 deaths; mortality, 35.7 per cent.
Secondary " 594 " 314 " " 52.8 "

A percentage which, it will be observed, corresponds very closely with that derived from observations in civil hospitals.

The statistics of amputation in the late war of the rebellion have not yet been all published; but, as far as they go, they serve to confirm what has been already said: thus 4806 *primary* amputations of the upper extremity recorded in Dr. Otis's *Surgical History of the War*, gave 821 deaths, or 17.08 per cent., while 1516 *intermediate* amputations gave 481 deaths, or 31.73 per cent., and 666 *secondary* amputations gave 163 deaths, or 24.47 per cent.

Causes of Death after Amputation.—The causes of death after amputation have been made the subject of special study by several writers, among whom may be particularly mentioned Malgaigne, James, Bryant, Holmes, and Birkett. The three last-named gentlemen are among the most recent authorities on the matter, and I will terminate this chapter by quoting some of the *conclusions* appended to their excellent papers. Mr. Holmes finds from examining the records of 300 cases—

"1. That a considerable proportion of cases must occur in hospital practice, in which death is really inevitable, although it is not known to be so at the time of amputation. . . .

"2. That of the fatal cases which remain, in about one-half death is due mainly to previous disease or injury.

"3. That secondary hemorrhage is hardly ever a cause of death, except in persons with diseased arteries.

"4. That death from exhaustion hardly ever occurs without previous disease, obviously proved both by symptoms and post-mortem appearances.

"5. That the other hospital affections (erysipelas, diffuse inflammation, and phagedæna or hospital gangrene) are rare in subjects previously healthy, and that, as a rule, they only prove fatal when they are the precursors of pyæmia.

"6. That therefore any attempt to estimate the dangers of amputation in hospital practice, or to diminish its mortality, must be based upon a knowledge of the conditions under which pyæmia occurs in cases treated separately, and in patients congregated in hospital wards." (*St. George's Hospital Reports*, vol. i., pp. 321–322).[1]

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[1] Mr. Holmes's second paper, based on 500 cases (*St. George's Hospital Reports*, vol. viii.) confirms the above conclusions.

Mr. Bryant's tables likewise include 300 cases, and from his "General Conclusions" I select the following:

"That *pyæmia* is the cause of death in 42 per cent. of the fatal cases, and in 10 per cent. of the whole number amputated.

"That exhaustion is the cause of death in 33 per cent. of the fatal cases, and in 8 per cent. of the whole number amputated.

"That the following causes of death are fatal in the annexed proportions:

	Of fatal cases.	Of whole number.
Secondary hemorrhage . .	7.0 per cent., or	1.66 per cent.
Thoracic complications . .	5.6 " "	1.33 "
Cerebral " . .	3.0 " "	.66 "
Abdominal " . .	1.4 " "	.33 "
Renal " . .	3.0 " "	.66 "
Hectic " . .	3.0 " "	.66 "
Traumatic " . .	7.0 " "	1.66 " —"

Pyæmia is the chief cause of death after pathological amputations, after those of expediency, and after primary amputations for injury.

Exhaustion is the chief cause of death after secondary amputations for injury, and ranks next to pyæmia as a cause of death after the primary, and those classed as pathological (see *Med. Chir. Trans.*, vol. xlii., pp. 85–90).

Mr. Birkett, from a study of 171 cases, in which the operation was performed either by himself or under his direction, concludes that a "large proportion of the patients submitted to amputation, when inmates of a metropolitan hospital, are the subjects of more or less advanced chronic disease of the thoracic or abdominal viscera," and that "the chances of death after operations appear to depend almost entirely upon the previous state of each patient's constitution" (*Guy's Hosp. Reports*, 3d s., vol. xv., p. 599).[1]

CHAPTER VI.

SPECIAL AMPUTATIONS.

UPPER EXTREMITY.

Amputations of the Hand.—Amputations of different parts of the hand are frequently rendered necessary by injuries, or by diseases of the bone, as in neglected cases of whitlow. As no mechanical contrivance can possibly equal the natural hand in utility, it should in all cases be the surgeon's object to save as much as possible; there is but one exception to this rule, and that is when in the case of the middle fingers it becomes necessary to go as high as the first interphalangeal joint; as there is no special flexor tendon for the proximal phalanx, it will, in such cases, be usually better to go at once to the metacarpo-phalangeal joint; but in the forefinger, even a single phalanx will be of use, as affording a point of opposition to the thumb, while the proximal phalanx of the little finger may be properly preserved, in order to give greater symmetry to the hand.

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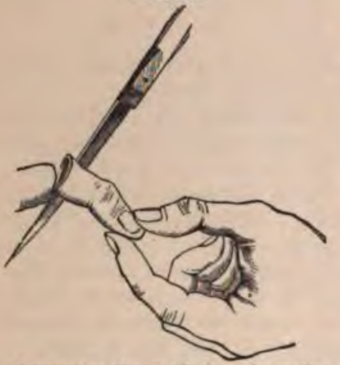
[1] In my article on Amputations in the *International Encyclopædia of Surgery*, vol. i., I have given many elaborate tables bearing upon the mortality and causes of death after amputation, for which I have not space here.

Fingers.—The fingers may be amputated at any of their joints, or through the phalanges: if the latter operation be decided upon, it may be done by cutting suitable flaps with a straight bistoury, and dividing the bone with cutting pliers or a small saw. Amputation of the terminal or middle phalanges may be done by opening the joint from the back of the finger, dividing cautiously the lateral ligaments, disarticulating, and cutting a palmar flap of sufficient length to cover the stump. In this operation it must always be remembered that the prominence of the knuckle is due to the *upper* bone, and that hence the incision must be made below the knuckle, or it will not expose the joint. The palmar flap may be made first, either by transfixion or otherwise, and the joint opened subsequently; I think, however, the plan first mentioned is the best. Another method is to attack the joint from the side, cutting one lateral ligament, disarticulating, and then making a long lateral flap from the other side of the finger: this has been particularly recommended in the case of the fore and little fingers, but I do not see that it possesses any advantage over the common palmar flap operation. There is usually but little hemorrhage after the removal of a phalanx, and if any vessels bleed, they can generally be controlled by means of torsion; in some cases, however, the digital arteries are much enlarged, and require ligature.

FIG. 48.

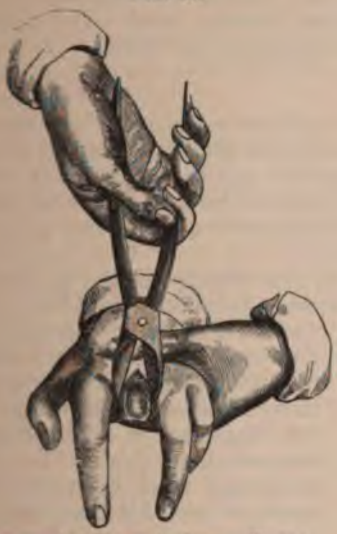


Amputation of part of a finger by cutting from above. (ERICHSEN.)

Amputation at the Metacarpo-phalangeal Joint is best done by the oval method, though it may also be conveniently executed by making two lateral flaps. In the oval operation, the point of the knife is entered just below the knuckle, on the back of the hand, and the blade is drawn obliquely downwards through the interdigital web, across the palmar surface of the finger, and obliquely upwards to the point of commencement; a few light touches of the knife free this oval flap, and disarticulation is then effected by cutting the extensor tendon (if it be not already divided) and the lateral ligaments. In the case of the forefinger the knife should be entered on the radial side, and in the case of the little finger on the ulnar side, instead of at the back of the joint. Some difference of opinion exists as to the propriety of removing the head of the metacarpal bone in these amputations. The hand may indeed be rendered more symmetrical by its removal, but this gain of symmetry is more than counterbalanced by the loss of firmness and strength entailed; besides, the removal of the head of the metacarpal bone exposes the patient to the risk of inflammation and suppuration in the deep tissues of the palm, and thus renders the operation more serious than it would be otherwise. Hence, if the metacarpal bone itself be uninjured, its head should be, as a rule, allowed to remain: if, however, it be decided to remove it, this can be easily effected by cutting it with strong pliers (Fig. 49), the section, in the case of the fore and little fingers, being oblique, so as to give a tapering form to the part when it is healed.

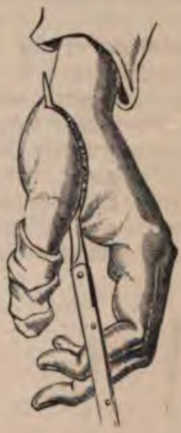
The entire thumb, with its metacarpal bone, may be amputated by making an oval flap from the palmar surface: in the case of the left thumb (Fig. 50), the joint may be first opened by an oblique incision on the back of the hand, beginning above and a little in front of the joint, and coming down as far as the web which separates the thumb from the forefinger; the palmar flap is then made by thrusting the knife upwards to its point of entrance, and cutting downwards and outwards; in amputating the right thumb, it is more convenient to make the palmar flap first, by transfixion, the remaining steps of the operation being done subsequently. The thumb alone is almost as useful as the other four fingers together; hence, in operations on this important member, no part should be sacrificed that can by any possibility be preserved.

FIG. 49.



Amputation of an entire finger. (SKEY.)

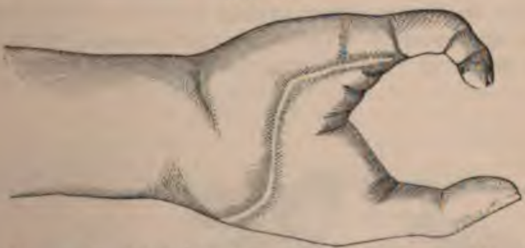
FIG. 50.



Amputation of the left thumb. (ERICHSEN.)

Amputation through one or more metacarpal bones may be required, and may be done by cutting from without inwards thick flaps of sufficient dimensions to cover the parts without undue stretching. In making these flaps, the palm should be respected as much as possible, the necessary incisions being preferably made through the dorsum of the hand. It is better to leave the carpal ends of the metacarpal bones, so as to avoid opening the wrist-joint. Any part of the hand that can be kept, should be scrupulously preserved, as even a single finger with the thumb is far more useful than the best artificial substitute. Fig. 51, from a case formerly under my care at the Episcopal Hospital, shows the result of an operation of this kind. If a metacarpal bone be injured without injury of its corresponding finger, the

FIG. 51.



Partial amputation of the hand. (From a patient in the Episcopal Hospital.)

former may be excised while the latter is retained, or the finger may, perhaps, be adapted to another metacarpal bone which has lost its own finger, as has been ingeniously done by Prof. Joseph Pancoast, of this city.

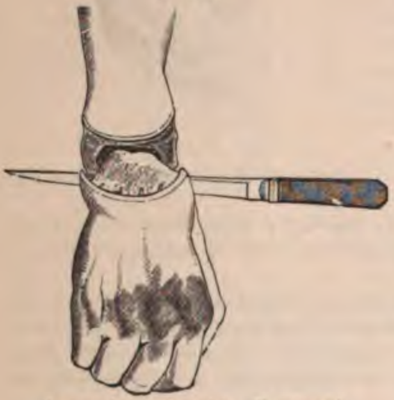
The risks of amputation below the carpus are slight, 7902 cases referred to in Dr. Otis's *Surgical History of the War,* having furnished but 223 deaths, of which 19 were after re-amputation at a higher point. The mortality of amputations through the hand is thus less than 3 per cent.

Amputations of the Arm.

1. *Amputations at the Wrist.*—The hand has occasionally been removed at the carpo-metacarpal articulation, or between the rows of carpal bones; the stumps thus formed are, however, irregular, and the carpal bones are apt to become subsequently diseased and to require removal. Hence, when it is necessary to invade the carpus at all, it is better to go at once to the radio-carpal joint, and amputate at the wrist.

Amputation at the wrist-joint may be conveniently effected by the circular operation, by means of the elliptical incision, by making oval flaps cut from without inwards, or by cutting a single flap from the palm of the hand. The resulting stump is a very good one, though it is said to be less suited for the adaptation of an artificial limb than one that is shorter. Its principal advantage is in its preserving the power of pronation and supination, though even this may be lost from inflammatory adhesions binding together the radius and ulna. Sixty-eight cases of this amputation recorded in Dr. Otis's *Surgical History,* gave only seven deaths, a mortality of but 10.6 per cent.

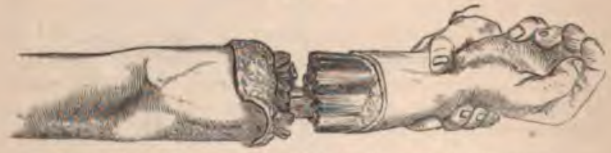
FIG. 52.



Amputation at the wrist. (ERICHSEN.)

2. *Amputation of the Forearm.*—The best operation in this locality is, I think, the circular; though excellent stumps may be produced by other plans, especially by the rectangular flap method of Mr. Teale. At one time I was in the habit of amputating the forearm by making antero-posterior flaps cut from without inwards, but having, on several occasions, met with dangerous secondary hemorrhage from the interosseous artery, which, in this operation, is apt to be cut obliquely, I have been led to prefer either the circular or Teale's, in neither of which is this risk so apt to be encountered. In any of the flap operations, particularly in the lower third of the forearm, trouble may be caused by the tendons projecting from their sheaths. Under such circumstances, the surgeon should draw them down.

FIG. 53.



Amputation of forearm by modified circular method. (BRYANT.)

and cut them off at as high a point as possible, that they may retract, and not interfere with the healing process. Perhaps the most brilliant operation on the forearm is that in which a dorsal flap is cut from without, and a palmar flap made by transfixion. The length of the flaps should be proportioned to the size of the limb, but two inches may be given as the average. Five or six vessels usually require ligature in amputations of the forearm, and of these the interosseous is that which is most likely to give trouble, from its tendency to retract between the bones, in which position its orifice may elude detection.

3. *Amputation at the Elbow* may be effected by either the circular or elliptical incision; it may also be done, though less conveniently, by making an anterior or an external flap by transfixion. It is sometimes recommended to leave the olecranon in place, dividing the ulna below it with a saw; no particular advantage, however, attends this plan, and the olecranon, if left, is apt to become necrosed, and interfere with the healing of the stump. Amputation at the elbow was done in forty cases during the late war, and only three of these terminated unsuccessfully.

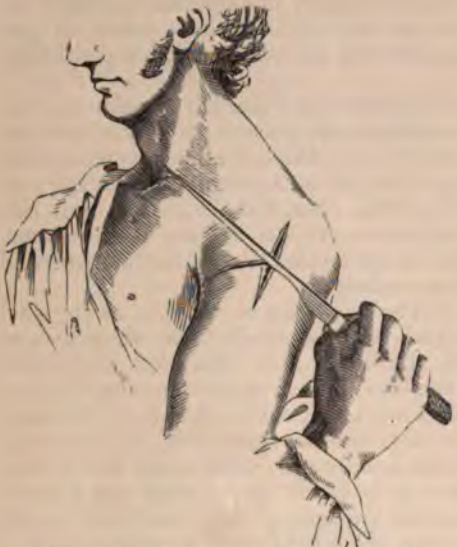
4. *Amputation through the Arm.*—The arm may be removed at any part and by any of the methods which have been described; those which seem to me the best are the oval and the modified circular. The bone, however, is situated so nearly in the middle of the limb, that an elegant and useful stump may be formed by any operation, and indeed the arm is frequently indicated as the typical locality for making double flaps by transfixion. If this operation be resorted to, lateral flaps are the best, and the outer should be cut first; the principal precaution to be taken is to divide the musculo-spiral nerve with a clean sweep of the knife around the back of the bone, before applying the saw. In amputating the arm, the possibility of a high division of the main artery must be remembered; occasionally the brachial will be the only vessel that requires ligature, though usually there will be bleeding from six or seven, or, if the parts have been long inflamed, twelve or fifteen. If the arm be amputated very high up, particularly if the limb be muscular, there may not be room for the application of the tourniquet in the usual place; it may then be safely applied to the axillary artery, the arm being kept extended, so as to make the head of the humerus project into the axilla, where it forms a firm point of resistance against which to exercise pressure; or the surgeon may, if he prefer, have the subclavian artery compressed as it passes over the first rib, by means of a wrapped key in the hands of an assistant.

Amputation at the Shoulder-joint.—This is in appearance a most formidable operation, and yet it is one of which the results are tolerably favorable. Thus, 841 cases, recorded in Dr. Otis's *Surgical History*, gave 595 recoveries and 246 deaths, a mortality of only 29.2 per cent. When performed for other than traumatic causes, it is still more successful. Amputation at the shoulder-joint may be practised in several ways, the most important being those commonly known by the names of Larrey, Dupuytren, and Lisfranc.

1. *Larrey's Method.*—The surgeon enters the point of a short knife below and a little in front of the acromion process, and makes a deep incision about three inches long, in the direction of the axis of the arm. From the middle of this incision, two others are made obliquely downwards (and slighty convex, if the limb be muscular), so as respectively to terminate at the points where the anterior and posterior folds of the axilla end in the tissues of the arm; it is usually directed that the anterior incision should be made first, as the posterior circumflex artery is larger than the anterior, but if the sub-

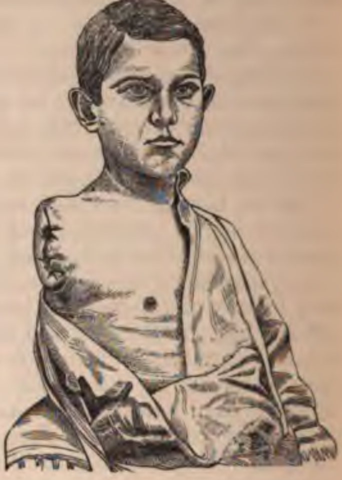
clavian be well commanded over the first rib, there need be no fear of hemorrhage, and it will then be most convenient to make the posterior incision first, that its position may not be obscured by bleeding from the other. The surgeon next disarticulates, rotating the arm first outwards so as to make tense the subscapular muscle, which he divides with a perpendicular stroke of the knife, then cutting the capsule and the tendon of the long head of the biceps, and finally rotating the arm inwards so as to reach the supra- and infra-spinatus muscles, and the teres minor. The lateral incisions are lastly connected by a transverse cut through the tissues of the arm, either from without or from within. Before this final incision (which divides the brachial artery) is made, an assistant should slip his thumb into the wound

FIG. 54.



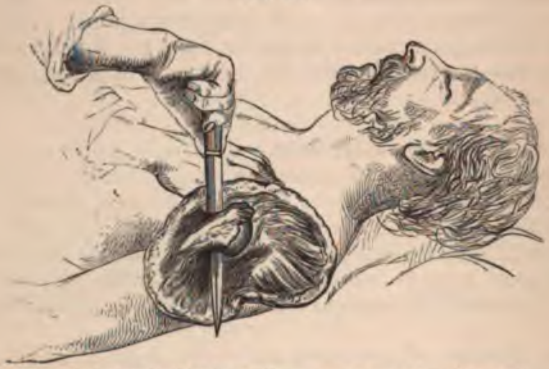
Amputation at shoulder-joint by Larrey's method.

FIG. 55.



Result of Larrey's amputation. (From a patient in the Episcopal Hospital.)

FIG. 56.



Amputation at shoulder-joint; Dupuytren's method. (BRYANT.)

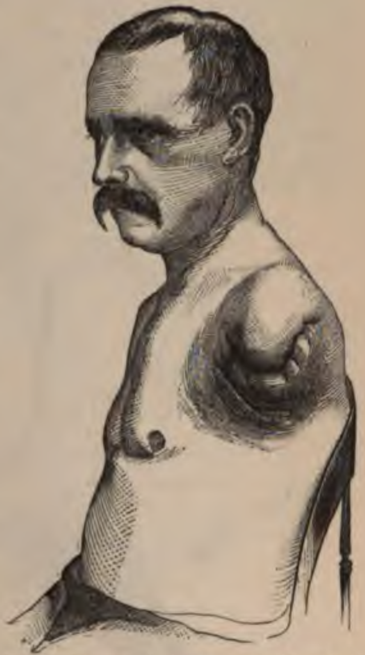
and control the vessel, which may always be found in the first muscular interspace from the anterior edge of the axilla; the limb being removed, the vessels are to be secured, and the edges of the wound brought together so as to make a linear cicatrix. The appearance of the stump resulting from this operation is well shown in the accompanying illustration (Fig. 55), from the photograph of a patient on whom I performed this amputation at the Episcopal Hospital.

2. *Dupuytren's Method.*—This method consists in making, either by transfixion or from without inwards, a large flap, embracing almost the whole of the deltoid muscle, then disarticulating, and finally cutting a short flap (in which is the vessel) from the inside of the arm. This operation is more quickly performed than Larrey's, but makes a larger wound, and is not, I think, so generally applicable. In either method the principal difficulty is in disarticulating, to accomplish which (in the case of fracture preventing the use of the arm as a lever in effecting rotation) it may be necessary to introduce the forefinger of the left hand into the capsule, and forcibly drag down the head of the bone so as to expose the ligamentous attachments. In making the deltoid flap by transfixion, the knife should be entered about an inch in front of the acromion process, and, being pushed directly across the joint and capsule, should be brought out at the posterior fold of the axilla. As in Larrey's operation, an assistant should slip his thumb into the wound, and secure the artery before the final incision is made.

3. *Lisfranc's Operation* consists in making antero-posterior flaps, which come together very much as the incisions in Larrey's method, over which it presents no particular advantage. The shoulder-joint can also be reached by a circular incision, as practised by Velpeau and others, and in fact all conceivable varieties of amputation at this point have been employed, and claimed as the best by different surgeons, though those which I have described have been most generally adopted.

Amputation above the Shoulder, or amputation of the arm with a part or the whole of the scapula, and perhaps a portion of the clavicle, is occasionally required in cases of accident or of disease. No special rules can be given for the performance of this operation, to which, whenever possible, excision of the parts concerned is to be preferred. In cases of injury, the surgeon must make his flaps as best he may, in view of the extent and direction of the laceration, and in cases of amputation for tumors, etc., must be guided by the size and shape of the morbid growth. The results of this operation have been more favorable than might have been anticipated: fourteen cases are on record, which, though the arm and a part or the whole of the scapula were torn off by accidental violence, terminated favorably, while fifty-one cases in which the arm and part or all of the scapula,

FIG. 57.



Result of amputation by Dupuytren's method.
(From a patient in the Episcopal Hospital.)

with or without a portion of the clavicle, were removed by the surgeon at the same operation, gave thirty-eight recoveries and only thirteen deaths.

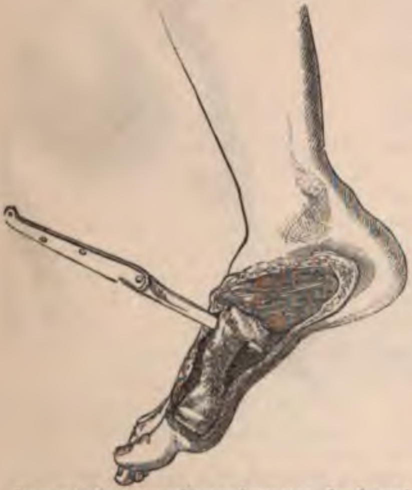
LOWER EXTREMITY.

Amputations of the Foot.—The phalanges of the toes seldom require amputation, but, if necessary, this little operation may be conveniently done, as in the case of the fingers, by opening the joint from the dorsum, and covering the stump with a plantar flap.

Amputation at the Metatarso-phalangeal Joint is best done by the oval incision. It must be remembered that the web reaches about half-way between the joint and the end of the toe; hence the incision must be placed high, or the joint will be missed. Disarticulation is facilitated by forcibly flexing the toe, and dividing the extensor tendon by a transverse incision. It is sometimes recommended that in amputating the great toe, the head of the metatarsal bone should be also removed; I do not think this desirable, as by so doing a very important point of support to the arch of the foot is taken away, an evil which would not be compensated for by the greater symmetry of the resulting stump.

Amputation of the Great Toe, with a part or the whole of its Metatarsal Bone, may be required. If the anterior portion or head only is to be removed, an oval incision may be employed, which is prolonged backwards for a sufficient distance on the side or back of the foot. The bone may be divided by cutting pliers or by a chain saw. If the whole bone is to be removed, it is better to shape an antero-lateral flap, by entering the knife on the back of the foot, between the first and second metatarsal bones, and on a level with the tarso-metatarsal joint, cutting forwards to the ball of the toe, then across to a point corresponding to the position of the web, and then backwards again along the inner edge of the sole; this flap is dissected up, taking care to keep it as fleshy as possible. The knife is then re-entered between the metatarsal bones, and made to cut directly forwards through the web. Then pressing the toe away from the next one, the surgeon, with the point of his knife, cautiously effects disarticulation, and separates the part to be removed, taking care not to wound the dorsal artery of the foot. Hemorrhage having been checked, the flap is brought down and attached by points of suture in the usual way.

FIG. 58.



Removal of metatarsal bone of great toe; flap formed; joint being opened. (ERICHSEN.)

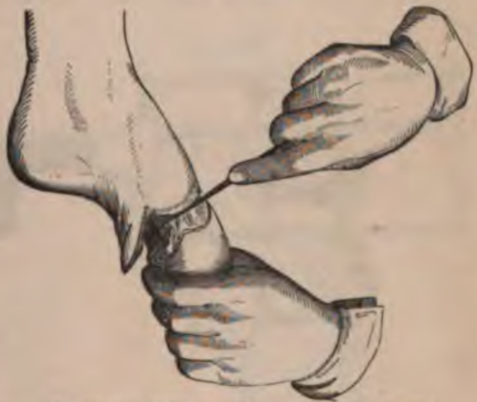
Amputation of the Fifth Metatarsal Bone may be effected by the oval incision, made so as to avoid wounding the sole. The point of the oval is usually made on the dorsum of the foot, and may be extended in a curve downwards and outwards to the edge of the sole, thus forming a curved triangular flap, which is dissected down to give more space. A somewhat similar modification of the oval incision is practised by A. Guérin, in amputating the metatarsal bone of the great toe.

Amputation of two or more of the Metatarsal Bones may be conveniently done by the oval operation, the point of the oval beginning on the dorsum above the joint at which disarticulation is to be effected, and its branches spreading to embrace the requisite number of toes.

Amputation through the Continuity of all the Metatarsal Bones is best done by cutting a short dorsal and a long plantar flap, the latter of which may be made, if preferred, by transfixion, sawing the bones on the same level, and bringing up the long flap, so as to free the cicatrix from pressure in walking. The resulting stump is well formed and useful.

Amputation of the Entire Metatarsus (which is said to have been practised by the North American Indians as a means of preventing the escape of prisoners) may be effected by making a long plantar and a short dorsal flap. The general line of the articulation is irregularly oblique, the base of the first metatarsal being much lower than that of the fifth. The second metatarsal dips in between the first and third, while this again articulates at a lower level than the fourth or fifth. The plantar flap may be cut first from without inwards, as directed by Mr. Hey, or disarticulation may be effected first, and the long flap made last, as practised by Lisfranc. The guides to the articulation are the prominent tuberosity of the fifth, and the tubercle of the first metatarsal bone (Lisfranc), or the tuberosity of the fifth metatarsal, and the prominence of the scaphoid (Hey). The French operation is a pure disarticulation, but Hey sawed across the projecting internal cuneiform bone. This amputation is somewhat difficult of execution, and is now seldom performed.

FIG. 59.

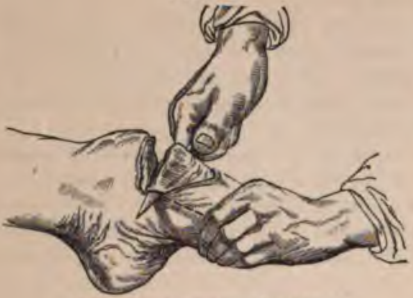


Amputation at the tarso-metatarsal joint. (SKEY.)

Chopart's Amputation removes all of the tarsus except the astragalus and the calcaneum. As in the case of the last described operation, the plantar flap may be made first, or not until after disarticulation has been effected; the former plan is, in some respects, the best, as allowing the flap to be more regularly shaped. The incision should start on the outside of the foot from a point midway between the external malleolus and the tuberosity of the fifth metatarsal bone, and on the inside from a point about half an inch behind the prominence of the scaphoid. Disarticulation may be much facilitated by forcibly bending the foot down, so as to make tense the anterior ligaments of the joint. The scaphoid bone has often been left, unintentionally, in performing this operation, the resulting stump being nevertheless quite satisfactory. Care must be taken, in the after-treatment, to prevent retraction of the heel, which is apt to occur, and which may require division of the tendo Achillis. Mr. Hancock has collected 152 cases of Chopart's amputation, of which 120 resulted in recovery with serviceable stumps, 2 in re-amputation, and 11 in death, while in 15 the result as regards utility of the limb was uncertain, and in 4, though life was preserved, the stumps were not satisfactory. The mortality is thus only 7.2 per cent.

Sub-astragaloid Amputation.—In this operation all the bones of the foot are removed except the astragalus. Lisfranc did this amputation by cutting a dorsal flap, Lignerolles with two lateral flaps, and Malgaigne by taking a single flap from the inner part of the plantar surface. The best plan, however, and that which I have myself followed, is to make a flap from the heel, as in Syme's operation (to be presently described), which flap is then brought over the astragalus and attached to a short dorsal flap in front. Mr. Hancock has collected twenty-two cases of this operation, the results of which appear to have been usually satisfactory.

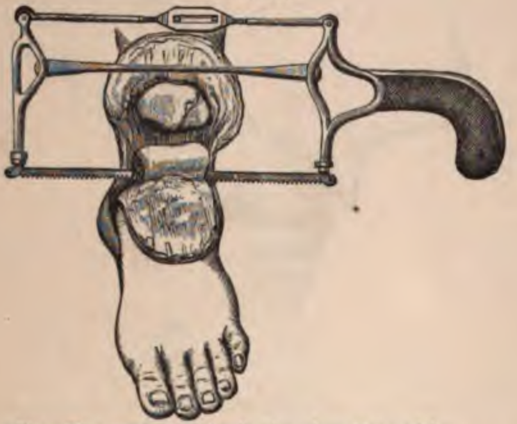
Fig. 60.



Chopart's amputation. (Bryant.)

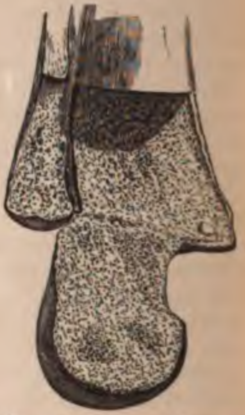
Pirogoff's Amputation. — In this operation the whole of the foot is taken away except the posterior part of the os calcis, which is brought up and placed in contact with the sawn extremities of the tibia and fibula, from which the malleoli have been removed.[1] The operation is thus done: a somewhat oblique incision, convex forwards, is carried across the sole of the foot from one malleolus to the other, and the flap thus marked out dissected backwards for about a quarter of an inch; a second incision, slightly convex forwards, is then made across the front of the ankle, so as to open the joint; the astragalus is next disarticulated, when the surgeon, applying a narrow-bladed saw or a "Butcher's saw" to the upper and posterior part of the calcaneum, behind the astragalus, divides it obliquely downwards, in the line of the plantar incision. The malleoli and articulating surface of the tibia are then likewise sawn off, and the two cut surfaces of bone approximated. If Butcher's saw be used,

Fig. 61.



Pirogoff's amputation. Application of saw to os calcis. (Erichsen.)

Fig. 62.



Bony union between calcaneum and tibia, after Pirogoff's amputation. (Hewson.)

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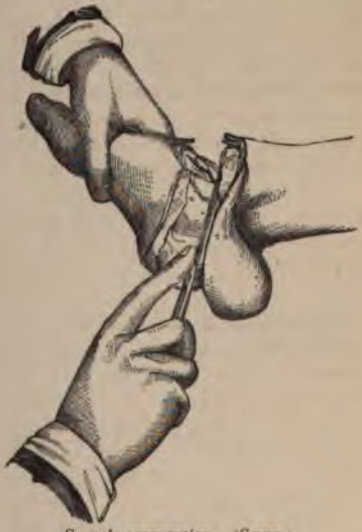
[1] Sir W. Fergusson, Prof. Agnew, and Dr. Quimby have modified this operation by leaving the malleoli and pressing up the sawn os calcis between them. I. S. Wight, of Brooklyn, saws through the calcaneum, and then removes the foot and malleoli together, without disarticulating.

the position of the blade may be reversed for the latter part of the operation, so as to saw off the malleoli from behind forwards. This amputation makes an admirable stump, the remaining portion of the calcaneum becoming firmly attached to the bones of the leg, and the natural length of the limb being retained. It is particularly adapted to cases of injury, though it may also be employed in those of disease, provided that the calcis itself be not involved. Hancock has collected 70 cases of Pirogoff's amputation, done by British surgeons, death occurring in only six, while a useful stump is known to have resulted in 57. Five required re-amputation. Seventy-seven operations collected from all sources by Gross (of Nancy) and Pasquier, gave only eight deaths, while useful limbs were known to have been obtained in 44 cases. Stephen Smith and Hewson have particularly investigated the merits of Pirogoff's amputation, and the latter believes it to be, in one point, superior to any[1] operation done higher up, in that it enables the patient to *run* upon his stump as well as to walk. The accompanying cut (Fig. 62), from Hewson's paper, shows very well the bony union between the calcaneum and the tibia in a successful case of this operation. The same precautions as to retraction of the heel are necessary in the after-treatment of this, as in that of Chopart's operation; the purpose was well accomplished in Hewson's cases by applying a weight of four or five pounds to the back of the leg, by means of a broad strip of adhesive plaster.

Amputation at the Ankle-joint (*Syme's Operation*).—The following is Mr. Syme's own description of this operation: "The foot being held at a right angle to the leg, the point of a common straight bistoury should be introduced immediately below the fibula, at the centre of its malleolar projection, and then carried across the integuments of the sole in a straight line to the same level on the opposite side. The operator having next placed the fingers of his left hand upon the heel, and inserted the point of his thumb into the incision, pushes in the knife with its blade parallel to the bone, and cuts close to the osseous surface, at the same time pressing the flap backwards until the tuberosity is fairly turned, when, joining the two extremities of the first incision by a transverse one across the instep, he opens the joint, and carrying his knife downwards on each side of the astragalus, divides the lateral ligaments, so as to complete the disarticulation. Lastly, the knife is drawn round the extremities of the tibia and fibula, so as to expose them sufficiently for being grasped by the hand and removed by the saw. After the vessels have been tied, and before the edges of the wound are stitched together, an opening should be made through the posterior part of the flap, where it is thinnest, to afford a dependent drain for the matter, as there must always be too much blood retained in the cavity to permit of union by the first intention."

FIG. 63.



Syme's amputation. (SKEY.)

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[1] Mr. Syme also claims this advantage for his operation at the ankle-joint.

This operation has been varied by other surgeons, some making the heel flap longer,[1] and others shorter, than directed by Syme himself. Again, some only dissect back the flap to the point of the heel, dividing the tendo Achillis and completing the separation of the calcaneum after disarticulation. However it be done, an excellent stump results, provided that care be taken to keep close to the bone in making the heel flap, so as not to destroy its vascular connections. The death-rate of Syme's operation is but small, 219 cases collected by Hancock having given but 17 fatal terminations, a mortality of less than 8 per cent. The stump is, according to Stephen Smith, better than that of Pirogoff's operation, for use with an artificial limb. Macleod and J. Bell modify Syme's operation by preserving the periosteum of the os calcis.

Other Amputations on the Foot.—Mr. Hancock has ingeniously combined Pirogoff's with the subastragaloid amputation, preserving the ankle-joint, and bringing the sawn surface of the os calcis into contact with a transverse section of the astragalus; in this operation the head of the latter bone is also removed. In the course of lectures (before the Royal College of Surgeons), published in the *Lancet* for 1866, in which this operation, which may be called *Hancock's*, is described, the same surgeon ably advocates the propriety of looking upon the foot as a whole, for operative purposes, and of dividing the tarsal bones with a saw, without regard to the position of the joints, taking care merely to remove all parts that are diseased or irretrievably injured. This is a revival of the old teaching of Mayor, of Lausanne, and, though contrary to the generally received views of modern surgery, is, I think, founded in reason; acting upon this principle, I myself in one case removed the front portion of the foot, sawing through the scaphoid bone, the posterior part of which was healthy, and removing the anterior diseased surface of the calcaneum; the case did perfectly well. By this proceeding amputations of the tarsus are greatly simplified, it being merely requisite to make antero-posterior flaps of sufficient size, and to saw off the diseased or injured parts of the foot. Tripier, of Lyons, has modified the subastragaloid operation by leaving the upper part of the calcaneum, which he saws through on a level with the sustentaculum tali, and at right angles to the axis of the leg; the external incisions are made as in Chopart's amputation.

The *statistics* of amputations of the foot and ankle are quite favorable; thus, in our late war, 790 amputations of the toes gave but six deaths, 119 partial amputations of the foot gave eleven, and 67 of the ankle-joint gave nine (*Circular No.* 6, S. G. O., 1865, p. 45).[2]

Amputations of the Leg.—The leg may be amputated at any part, the rule being to give the patient, in every case, as long a stump as possible. It was formerly customary, in the case of laboring men who could not afford to procure costly artificial limbs, to amputate just below the tubercle of the tibia, that a peg might be adapted which would press on the front of the knee; but by using a short peg with a socket, the limb can be fixed in the extended position, so that the benefits of a long stump can now be equally well given to patients in all conditions of life.

Amputation at the Lower Third of the Leg may be conveniently performed by the ordinary circular method, or by making two lateral flaps principally composed of skin, and dividing the muscles by a circular incision a short distance above.

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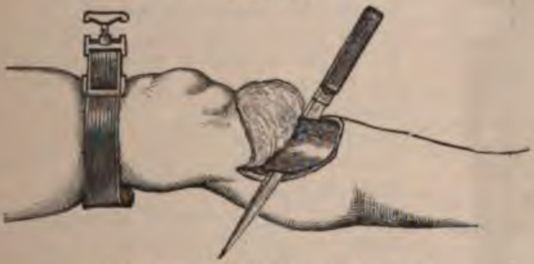
[1] Dr. J. A. Wyeth, of New York, has shown, by numerous dissections, that the chief blood supply to the heel flap is from the calcaneal branches of the external plantar artery, and that hence a *long* flap is more likely to preserve its vitality than a short one.

[2] Larger's tables, however, derived principally from French sources, give a less favorable picture—149 complete amputations of the foot having furnished but 90 recoveries, and 80 partial amputations but 57 recoveries.

Amputation at the Middle or Upper Part of the Leg, provided that the limb be not too muscular, may be done by the common double-flap method, a short anterior skin flap being cut from without inwards, and a long posterior flap by transfixion. When the calf of the leg is very large, this plan gives an unwieldy posterior flap, which must be trimmed before adjustment, and is even then clumsy and troublesome; hence in such cases the flap should be cut from without inwards, or, better still, Sédillot's or Lee's method may be adopted. *Sédillot's* plan consists in cutting by transfixion a single flap from the outside of the limb, while the tissues on the inside are divided by a transverse incision slightly convex forwards; after sawing the bones, the large flap is brought around and attached by stitches, forming a beautiful stump. *Lee's* method, like that of Teale, consists in making rectangular flaps, of which, however, the longer is formed from the tissues of the calf; it embraces only the superficial layer of muscles, the deep layer being transversely divided on a level with the line of the short flap.

In whatever way the flaps are formed, the bones must be cleared for the saw by a circular sweep of the knife, and in cutting between the bones special care must be taken not to turn the edge of the knife upwards, lest the tibial arteries should be cut at too high a point—an accident which by the subsequent retraction of the vessels might cause trouble in arresting the hemorrhage. In sawing the bones, the fibula may properly be divided half an inch higher than the tibia; it is often recommended to saw the edge of the latter obliquely, under the impression that it is thus less likely to perforate the anterior flap; I believe, however, that, except from undue tension, this accident is not likely to occur, and that the risk of necrosis is increased by the oblique division of the tibial spine. If it be done at all, it is best done by rounding off the bone with a Butcher's saw, as recently advised by Mr. Porter, of Dublin. A preferable plan is, I think, to preserve a short flap of periosteum, which is allowed to fall over the sawn surface of the tibia, as recommended by Ollier, of Lyons.

FIG. 64.



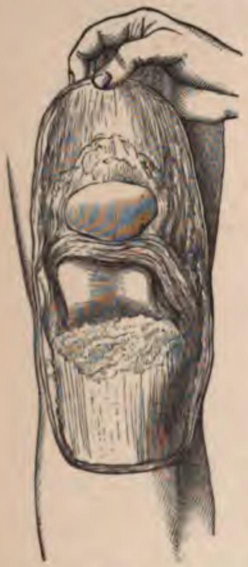
Flap amputation of the leg. (ERICHSEN.)

Four or five arteries usually must be tied in amputations of the leg, and in cases where the vessels are enlarged by the inflammatory process a much larger number may need ligature; while, on the other hand, if the section be made above the origin of the tibials, the popliteal alone may require attention. A great deal of trouble is occasionally experienced in endeavoring to secure the anterior tibial, owing to its retraction above the section of the interosseous membrane. A very good plan in such a case is to turn the patient on his face, when the weight of the stump will tend to extend the limb, thus bringing the artery into the direction of a straight line, and making it much easier of access. For all amputations of the leg or parts below, the tourniquet may be conveniently applied to the popliteal artery, a large compress being placed over the vessel, and the plate of the instrument fixed at a point diametrically opposite, above the knee.

Amputation at the Knee-joint is comparatively a modern operation. Its introduction into general surgical practice is principally due to the efforts of Velpeau, though it has probably been more frequently resorted to in Great Britain and in this country than on the continent of Europe. It may be done by either the circular or the elliptical incision, or by means of flaps.

Elliptical Method.—In this operation, which bears the name of Baudens, the surgeon enters his knife three fingers' breadth below the tuberosity of the tibia, cutting at first transversely, then obliquely upwards and around the limb to a point in the popliteal space one finger's length above the joint; the incision then passes transversely across the back of the limb, and is continued obliquely downwards to its point of commencement. This oval flap is dissected up to the line of the joint, and disarticulation easily effected by severing the ligamentum patellæ, and the lateral, crucial, and posterior articular ligaments. The semilunar cartilages are usually removed, though A. Guérin advises that they be allowed to remain. The articular cartilage may properly be left, though, if preferred, it may be removed by sawing around the condyles of the femur with Butcher's saw, or the condyles themselves may be removed in the same way; the statistics of the operation show, however, according to Dr. Brinton, that it is rather better to allow the condyles to remain. Some difference of opinion prevails as to whether or no the patella should be removed. I think, with Mr. Erichsen and Mr. Pollock, that it is better to retain it, and its retraction may be prevented, as suggested by the first-named surgeon, by turning up the flap and dividing the insertion of the quadriceps femoris muscle.

Fig. 65.



Long anterior flap at knee. (Erichsen.)

Anterior Flap Method.—This, which is the best of the flap methods, consists in making a long, rather square, cutaneous flap from the front of the leg, disarticulating, and cutting a short posterior flap by transfixion. The *posterior flap method*, in which a large fleshy flap is formed from the calf, is easier of execution, but less satisfactory in its results. The *lateral flap method*, of Rossi, was a good deal employed during our late war, and has the advantage of affording room for drainage at the lowest part of the wound. In any form of knee-joint amputation, the popliteal artery, with perhaps some of its branches, and the articular arteries, will require ligation.

The statistics of knee-joint amputation have been investigated by Dr. John H. Brinton, of this city, in an elaborate paper in the *Amer. Journ. of Med. Sciences* for April, 1868. He finds that 164 cases from American and foreign sources gave 111 recoveries and 53 deaths, a mortality of 32.31 per cent. Of 211 cases recorded in the office of the Surgeon-General, U. S. A., 106 died, or 50.2 per cent. The annexed table shows the respective mortality of amputations of the leg and of the thigh, compared with those of the knee-joint, in cases of gunshot injury.

	Cases.	Deaths.	Mortality, per cent.
Amputation of the leg[1]	3278	1089	33.22
" at the knee-joint[2] . .	296	181	61.15
" of the thigh[1]	3516	2715	77.22

In amputation at the knee-joint for chronic disease, the mortality is given by Dr. Brinton at 22.58 per cent., a death-rate which does not differ materially from that of amputation under similar circumstances either just above or just below the joint; the death-rate of this amputation for traumatic causes generally, he gives at 40.62 per cent.

Amputation through the Condyles of the Femur, or at the knee as distinguished from the knee-joint, is best done by Carden's method, the superiority of which over that proposed by himself has been candidly acknowledged by Prof. Syme. In this operation a single broad flap is taken from the front of the knee, the condyles being sawn through on a level with a simple transverse incision made below. The patella is removed, and the condyles may be advantageously divided in a curved line by using Butcher's saw. This operation gives an excellent stump, and is particularly applicable to cases of disease of the knee-joint, for which, indeed, it is claimed by Mr. Syme to be in every way superior to the operation of excision. Its results are very favorable, 30 cases of all kinds having given in Mr. Carden's hands a mortality of but 5, and 32 cases in Volkmann's hands a mortality of but 7. The resulting stump is longer and more serviceable than that from amputation of the thigh, and the medullary cavity not being involved, there is less risk of diffuse suppurative osteo-myelitis and consequent pyæmia.

Amputations of the Thigh.—Amputation of the thigh is frequently required in cases of both disease and injury. The operation may be done at any part of the limb, and the mortality is directly proportional to the proximity to the trunk of the line of section.

Supra-condyloid Amputation of the thigh is the name proposed by Stokes, of Dublin, for a modification of Carden's method of amputating at the knee; in this modification an oval flap is taken from the front of the leg, there being also a posterior flap fully one-third of the length of the anterior; the femoral section is made at least half an inch above the antero-superior edge of the condyloid cartilage, and the cartilaginous surface of the patella is removed by means of a small saw. A similar operation is that known as Gritti's, from the name of an Italian surgeon by whom it was first suggested. Dr. Weir, of New York, has collected 76 cases of one or other of these operations occurring in civil practice, the number of deaths having been 22, or nearly 29 per cent.

Amputation at the Lower Third of the thigh may be conveniently done by the ordinary double-flap operation. Mr. Erichsen recommends the operation by lateral flaps, for this situation, and I doubt not that an excellent stump may be obtained by this method. But I have myself always practised, in amputating at the lower third of the thigh, the antero-posterior flap method, and I have found it perfectly satisfactory. The anterior flap is cut first, from without inwards, and should be about four inches in length, extending to the upper edge of the patella; it should be rather square in shape, with the corners rounded off, and should embrace all the tissues down to the bone. The posterior flap, which contains the main artery, is made by transfixion, and should be about the same length as the other, thus allowing for the inevitable retraction of the muscles at the back of the thigh. Both flaps are then turned back, when a circular sweep of the knife clears the bone for the application of the saw. When the flaps are adjusted, it will be found that the bone is well covered by the front flap, and the resulting cicatrix is drawn entirely behind the line of pressure. Seven or eight vessels usually require ligature, though, if the case be one of chronic joint disease, the number may be larger.

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[1] See Table on page 108.

[2] See Dr. Brinton's paper, and Legouest, op. cit., p. 735.

Amputation at the Middle or Upper Third of the thigh, if the limb be not too muscular, may be done in the same way, by antero-posterior flaps, one or both made by transfixion, according to circumstances. But if the limb be a large one, a better stump can be made by resorting to the modified circular operation, as practised by Syme and Liston, making short skin flaps, and dividing the muscles at a higher point by a circular incision (see Fig. 41). The posterior muscles of the thigh always retract more than the anterior, and should, therefore, be cut rather longer. In amputating at the upper portion of the thigh, there is scarcely room for the application of the tourniquet, and the surgeon, therefore, commonly has to rely upon manual compression of the femoral artery, as it passes over the brim of the pelvis, though in some cases the aortic tourniquet might perhaps be advantageously employed. If manual pressure be resorted to, the assistant who has charge of this department should grasp the great trochanter with the fingers of the hand corresponding to the limb to be removed, and press firmly on the artery as it emerges from beneath Poupart's ligament with the thumb of the same hand; the opposite thumb is superimposed to assist and regulate the pressure, and to prevent any risk of slipping.

In cases of injury, the form and extent of the laceration will often compel the surgeon to make irregular flaps, and to cover his stump as best he may under the circumstances. Oblique flaps may be employed in such a case, or a single long flap from any part of the thigh; it is more important to make the amputation at as low a point as possible, than to follow any one or other particular mode of operating.

Amputation through the Trochanters may be occasionally required in cases of injury, or of malignant tumor involving the lower part of the femur. It is a procedure of less risk than exarticulation of the whole limb, and, in cases of malignant disease, appears to be no more likely to be followed by a return of the affection, than the graver operation. It is, moreover, very easy to convert this amputation into a disarticulation, by dissecting out the head and neck of the femur, if these parts be found to be diseased.

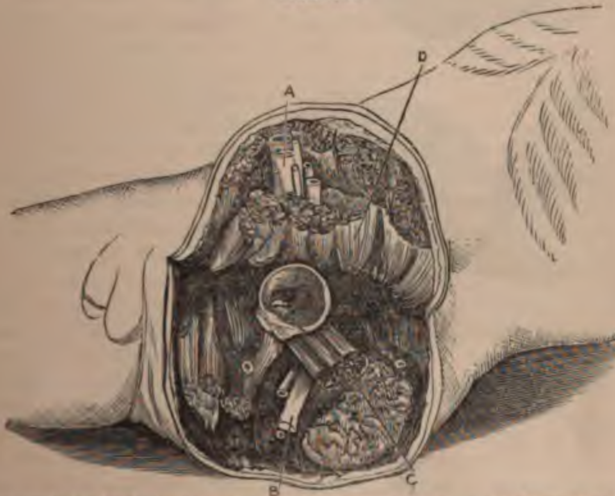
Teale's Amputation by Long and Short Rectangular Flaps makes a beautiful and most serviceable stump when applied to the thigh, but is objectionable on account of requiring the bone to be sawn at a much higher level than would be necessary with the ordinary operations: thus, if the laceration of the soft tissues extended to the upper border of the patella, and the thigh was only sixteen inches in circumference (by no means a large measurement), the long flap would need to be eight inches square, and the bone would be divided at just about its middle, fully four inches higher than would be required by the common double-flap operation.

Amputation at the Hip-joint.—This, which may fairly be considered the gravest operation in the whole range of surgical practice, is a procedure of comparatively recent introduction. The first case which is usually classed as an amputation at the hip-joint is that in which Lacroix (1748) removed the right thigh at the joint, on account of gangrene, which affected both limbs, and had been produced by the use of ergot. The amputation had been nearly completed by nature, and he merely divided with scissors the round ligament and the sciatic nerve. Four days afterwards he amputated, through the line of separation, the left thigh at the trochanters; the patient, who was a boy of fourteen, survived the last operation for eleven days. Perault, in 1774, performed a somewhat similar operation, in a case of gangrene from external violence, the patient recovering. The first genuine case of hip-joint amputation through living parts was done by Kerr, of Northampton, about the same time, on a girl of eleven years, suffering from hip disease complicated with pelvic abscess and pulmonary phthisis; she died on the eighteenth day. The first case of this amputation for gunshot injury was Larrey's, in 1793; while the first, undisputed, successful case in military practice was that of Mr. Brownrigg, in 1812.

A great many different plans have been suggested for effecting disarticulation at the hip-joint—Farabeuf has collected more than forty-five—but I shall content myself with describing five principal methods, viz., the oval, the modified circular, that by a single flap, that by antero-posterior, and that by lateral flaps.

Oval Method.—This has not been employed very often. It is done by entering the point of a strong but short knife on the outside of the limb, either over the trochanter or below the anterior superior spinous process of the ilium, and making two oblique incisions, one forwards and downwards, and the other backwards and downwards, to meet in a transverse line on the inside of the thigh. The muscles are divided in the same lines or a little higher, and disarticulation being effected from the outside of the joint, any remaining tissue is severed, as in Larrey's shoulder-joint amputation, by a single stroke of the knife. Malgaigne recommends a preliminary longitudinal incision, by which the operation is still more assimilated to that of Larrey on the shoulder. On a slender limb this form of amputation would give an admirable stump, but it is obvious that under opposite circumstances the

FIG. 66.



Amputation at the hip by the long anterior and short posterior flap. A. The femoral and profunda vessels, with branches of the anterior crural nerve. B. The great sciatic nerve and its companion artery. A large branch of the sciatic artery is seen in front. C. The muscular mass from the tuber ischii and the obturator externus muscle. Large branches are seen on either side from the profunda and gluteal. D. The psoas and other muscles immediately in front of the joint. (HOLMES.)

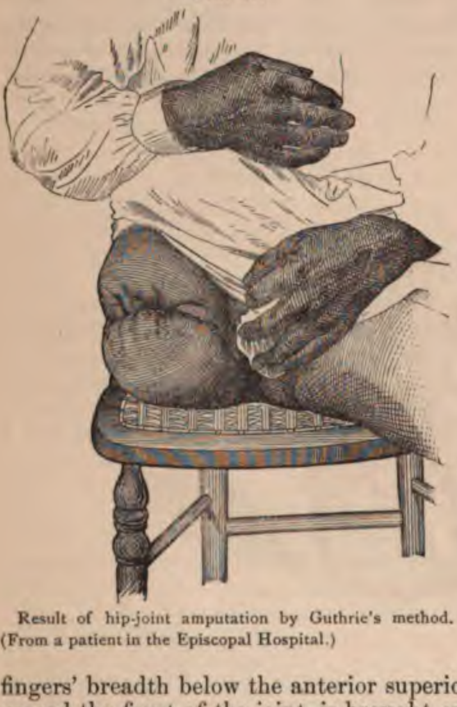
adductor muscles of the thigh would form a cumbrous mass, which would require retrenchment before the wound could be properly closed.

Modified Circular Operation.—This is done by cutting, from without inwards, short antero-posterior cutaneous flaps, and then dividing the muscles on a level with the joint by a circular incision. This method has been successfully employed by several American surgeons, including the late Dr. J. Mason Warren, of Boston, and is particularly adapted to cases of tumor encroaching on the upper part of the thigh.

Single Flap Method.—In this operation, a single, large, anterior flap is cut, either by transfixion (Manec), or from without inwards (Plantade, Ashmead). The soft parts on the back of the limb are divided by a circular incision, either before or after disarticulation. In other forms of this operation the flap has been taken from the inside, or even from the back of the limb. The single flap method might be desirable in a case in which the laceration of the soft parts was such as to forbid any other, but, when the surgeon has a choice of operations, it is better to employ either the oval or modified circular, or the double flap method of Guthrie, which will be presently described.

Antero-posterior Flap Method.—There are three varieties of this operation, which bear the names, respectively, of Béclard, Liston, and Guthrie. *Béclard's* operation consists in making both flaps by transfixion. It is thus performed: The point of a long straight knife is entered a little above the position of the great trochanter, thrust across the limb, dipping slightly backwards so as to graze the back of the cervix femoris, and brought out at the innermost part of the gluteal fold; a posterior flap is thus cut from the gluteal muscles, and the surgeon then re-entering his knife at the same point, pushes it in front of the joint, and, bringing it out as before, cuts an anterior flap from the front of the thigh. The plan which is more commonly adopted in England and in this country, and which is essentially that of *Liston*, differs from Béclard's in that the anterior flap is cut first, and that the knife, instead of being entered just above the trochanter, is thrust in about two fingers' breadth below the anterior superior spine of the ilium, and having grazed the front of the joint, is brought out just above the tuber ischii; the flaps thus formed are more oblique than in the French operation. *Guthrie's* plan, which seems to me to be better, differs merely in that the flaps are cut from without inwards; the operation is done with a small knife, and the posterior flap should be cut first. It is not quite so rapidly executed as the operation by transfixion, but is more certain of affording well-shaped flaps, and, I think, gives a better stump; this operation has been several times

Fig. 67.



Result of hip-joint amputation by Guthrie's method. (From a patient in the Episcopal Hospital.)

employed in this country, and is that to which I have myself resorted in four cases in which I have had occasion to perform this operation.

Lateral Flap Method.—This method, as its name implies, consists in making two flaps, from the outside and the inside of the limb. Larrey and Lisfranc made both flaps by transfixion, the former cutting the inner flap first, while the latter began with the outer. Dupuytren modified this operation by shaping the internal flap from without inwards. Neither of these plans appears to present any advantages over those which have been previously described.

Whatever method be employed in amputating at the hip-joint, the surgeon must take special precautions against the occurrence of hemorrhage, for a very few jets from the femoral artery, in this situation, will almost insure the death of the patient. Larrey directed that the main vessel should always be secured in the groin, as a preliminary measure, and this plan has been since frequently followed. It seems to me, however, that the extensive separation of the artery from the surrounding tissues, which is unavoidable in this preliminary ligation, must expose the patient to greater risk of secondary bleeding, than when the vessel is simply picked up by forceps or tenaculum, after division, as in other amputations. Hence, I think it better to rely upon mechanical means to control the circulation, or, in the absence of these, to trust to the manual pressure of intelligent assistants.

The circulation can be conveniently controlled by compressing the aorta, either with Lister's instrument (Fig. 28), a modification of Dupuytren's compressor, or with the apparatus which has been repeatedly used in this city under the name of the *abdominal tourniquet*, and which is merely an enlarged form of that devised by Mr. Skey (Fig. 27). Spence prefers to make pressure by putting a thick pin-cushion over the aorta, and keeping it in place by surrounding the body with an elastic band.

In addition to the aortic compressor, it is desirable to have in readiness a large flat sponge, as suggested by Mr. Butcher, for application to the whole posterior flap, while the surgeon's attention is given to securing the main artery which is in the anterior.

In order to prevent the loss from the general circulation of the blood *which is in the limb*, an ingenious suggestion of Dr. Erskine Mason should be adopted; this consists in rendering the part bloodless by the application of Esmarch's bandage and tube, the latter being fixed just *below* the line of incision, and kept in place during the operation.

Although the benefits derived from the use of the aortic compressor in this operation are unquestionable, yet the pressure necessarily exercised upon the important nervous structures contained in the abdominal cavity must be at least undesirable, if not positively injurious; hence the vessels should be secured promptly, that this pressure may not be continued longer than is absolutely necessary. The point at which the pad of the compressor should be applied is on a level with the umbilicus, and, usually, a little to its left side, though this must be determined by feeling for the pulsation of the aorta; it is well, before screwing down the pad, to roll the patient gently over to the right side, that the bowels (which should have been previously emptied by a dose of castor oil and an enema) may, as far as their mesenteric attachments will allow, fall out of the line of pressure. Should it be determined to rely on manual compression, this may be applied to the abdominal aorta (if the patient be very thin), to the external iliac artery just within the brim of the pelvis, or to the femoral as it emerges from beneath Poupart's ligament; the hands of an assistant should moreover follow the knife of the operator, and catch the artery in the anterior flap as soon as it is cut, or, if the flap be made by transfixion, before the section is completed. Dr. Woodbury, of this city, and Dr. Van Buren, of New York, have suggested that the iliac artery should be compressed by an assistant's hand introduced into the rectum, and an instrument for making pressure from the same direction has been devised by Mr. R. Davy, of London, who reports ten cases thus treated, with a combined loss of less than seventeen ounces of blood.

After the operation the stump may be closed in the usual way, the deep parts of the wound being approximated by the use of suitable compresses.

The statistics of hip-joint amputation are more favorable than might be expected from the severity of the operation: of 633 cases of all kinds collected for me by Dr. F. C. Sheppard, of this city, 220 are known to have ended in recovery, and 393 in death, while the result in 20 is undetermined; of these, there were 43 cases of re-amputation of stumps, of which 28 were successful. My own tale of cases is four operations with two recoveries and two deaths. The following tables exhibit—*first*, the comparative mortality of hip-joint and thigh amputations, for the causes met with in civil life, and in military surgery; *second*, the comparative mortality of these operations, according as they were performed, in civil life, for injury or disease; and *third*, the statistics of hip-joint amputation for gunshot injuries, with reference to the periods at which the operations were performed.

Table showing Results of Hip-joint, as compared with Thigh Amputation, for Causes incident to Civil Life, and in Military Surgery.

	Civil Practice.			Gunshot Wounds.			Aggregates.		
Amputation.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.
Hip-joint,[1]	395	186	47.1	238	207	87.3	633	393	64.1
Thigh,[2]	2090	862	41.2	3516	2715	77.2	5606	3577	63.8

Table showing Mortality of Hip-joint, and of Thigh Amputation, for Injury, and for Disease, in Civil Life.

	Amputation for Injury.			For Disease.		
Locality.	Cases.	Deaths.	Mortality, per cent.	Cases.	Deaths.	Mortality, per cent.
At hip-joint,[3]	71	47	66.1	276	105	40.2[5]
In continuity of thigh,[4] . . .	964	576	59.7	1465	477	32.5

Table showing Results of Hip-joint Amputation in Military Practice, according to the Period at which the Operation was performed.[6]

Period of operation.	Cases.	Died.	Recovered.	Doubtful.	Death-rate.
Primary, . . .	96	89	7	. .	92.7
Intermediate, . .	63	59	4	. .	93.6
Secondary, . .	27	17	10	. .	62.9
Re-amputations, .	7	3	4	. .	42.8
Not stated, . .	45	39	5	1	88.6
Aggregates, . .	238	207	30	1	87.3[5]

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[1] International Encyclopædia of Surgery, vol. i., p. 676.

[2] Ibid., p. 630.

[3] Ibid., p. 676.

[4] Erichsen's Surgery, vol. i., p. 80.

[5] Doubtful cases omitted in computing percentages.

[6] International Encyclopædia of Surgery, vol. i., p. 676.

CHAPTER VII.

EFFECTS OF INJURIES IN GENERAL; WOUNDS.

EXTERNAL violence or injury, of whatever kind, affects the state of the part to which it is immediately applied, and the general condition of the patient at the same time. Hence the effects of injuries are said to be both *local* and *general* or *constitutional*. The local effects of external violence vary according to the nature of the violence and the circumstances under which it is inflicted; the constitutional effects, though very different in degree, are the same in kind for all forms of injury.

CONSTITUTIONAL EFFECTS OF INJURIES.

These may be either immediate or remote. The immediate constitutional effect of an injury is called *shock*, which, if present in an aggravated degree, constitutes *collapse*.

Shock or Collapse is a condition, of the essential nature of which, it must be confessed, we are as yet in ignorance. It is often spoken of as purely an affection of the nervous system, and an analogy is drawn between this and hemorrhage as an affection of the vascular system; yet this view is contradicted by the fact that very serious lesions of the nervous system are not necessarily, nor indeed commonly, accompanied by shock. Experimental physiology has shown that large portions of the brain can be cut away from birds, without the development of this condition, except in so far as would be accounted for by the mechanical injury, and a similar experience is revealed by the study of morbid anatomy. No one would pretend to say that the formation of an abscess in the brain, or the degeneration of large tracts of the spinal cord, is accompanied by shock, and yet this ought to be the case if shock were purely an affection of the nervous system. In fact, here, as we saw in studying the process of inflammation, it is impossible reasonably to mark out and divide the nervous from the vascular system, or either from the parenchymatous structures around them, and say this is, and that is not, the seat of the affection. Shock is the general or constitutional effect of injury, and as the synergy of health unites all the tissues of the human body in normal life and action, so under the effect of injury they are still united by sympathy, and one tissue cannot suffer without the others.

Still, this sympathy is brought out through the agency of the nervous system, by a process of reflex action in fact, and, accordingly, it is not surprising to find that the symptoms of shock can be artificially induced by irritation applied directly to certain nerve structures. Drs. Mitchell, Morehouse, and Keen, of this city, who have devoted special attention to this subject, give the following explanation as to the probable mode in which the symptoms of shock are brought about: "These very interesting states of system," they say, "may be due, it seems to us, either to an arrest or enfeeblement of the heart's action through the mediation of the medulla oblongata and the pneumogastric nerves, or to a general functional paralysis of the nerve centres, both spinal and cerebral, or finally to a combination of both causes;"[1] and from an experimental investigation of the subject, Dr. C. C. Seabrook concludes that the phenomena of shock are due to paralysis of the vaso-motor centres.

Hence, while it is incorrect to speak of shock as exclusively an affection of the nervous system, it is through the agency of that system that its phenomena are brought about, and it is to a clearer understanding of the laws of nervous action that we must look for more definite and precise ideas as to the essential nature of this curious physical condition.

A good deal of confusion exists as to the meaning of the word shock, from this condition not being distinguished from others which often coexist with it, especially cerebral and spinal concussion and mental perturbation. Thus, a violent blow on the head may doubtless be accompanied by shock, but it will also probably be accompanied by cerebral concussion, an entirely distinct affection, and yet one which is not unfrequently spoken of by surgical writers as a typical instance of shock. Again, mere mental emotion, trepidation, or fright, may cause fainting or even death, and yet this is not shock in the true sense of the term. That true shock is a purely physical condition is seen from its occurrence in the lower animals, even in those which are cold-blooded, and from its being met with after operations done while the patient is under the full influence of an anæsthetic, and while mental emotion is therefore out of the question. Still, so intimately connected are mind and body, that it is often in practice difficult, if not impossible, to separate the mental condition from the purely physical state of shock.

Causes of Shock.—While in general terms it is correct to say that every injury produces a certain amount of shock, yet there can be no doubt that certain classes of injury are more liable to be followed by this condition than others, that shock is particularly apt to follow injuries of certain parts, and that the susceptibility to shock of any individual may vary with the particular circumstances to which he is subjected at the time of receiving the injury. *Gunshot wounds* have always been looked upon as especially apt to be followed by shock. "When a bone is shattered," says Mr. Longmore, "a cavity penetrated, an important viscus wounded, a limb carried away by a round-shot, pain is not so prominent a symptom as the general perturbation and alarm which supervene on the injury. . . . This emotion is in great measure instinctive; it is witnessed in the horse mortally wounded in action no less than in his rider; it is sympathy of the whole frame with a part subjected to serious injury, expressed through the nervous system." Severe *lacerated and contused wounds*, such as are produced by railroad and machinery accidents, are very frequently followed by shock in a marked degree. One of the most decided instances of shock that I have ever witnessed was in the case of a lad whose thigh was caught in a machine called a "lapper," in a rope factory. The whole limb, from the toes to above the middle of the thigh, was marked by punctures from the teeth of the machine, which were of steel and over three inches long; the thigh was broken, one of the punctures rendering the fracture compound, while another penetrated the knee-joint. There was comparatively little hemorrhage, and absolutely no exhibition of mental emotion; yet there was profound shock, from which even partial reaction did not occur until nearly thirty hours after the accident. *Burns and scalds*, involving a considerable extent of surface, are apt to be attended with severe shock, which not unfrequently proves fatal without the occurrence of reaction.

Other things being equal, the degree of shock is usually proportionate to the severity of the injury received, but the modifying circumstances are so many and so effective, that the exceptions to this rule are almost as numerous as its instances.

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[1] Circular No. 6, S. G. O., 1864, p. 2

The degree of shock varies with the part of the body injured; in the case of the extremities, the shock appears to be greater as the lesion is nearer the trunk, while wounds of the abdominal cavity are attended with more shock than those of the chest. Drs. Mitchell, Morehouse, and Keen infer from the cases which they have examined, that gunshot wounds of the upper third of the body are more likely to be attended with shock than those of other regions. The shock attending injuries of the head or spine is very apt to be complicated by concussion or paralysis. Wounds of the testicle are frequently accompanied by a state of shock, much more marked than can be accounted for by the severity of the injury.

The various circumstances by which a patient is surrounded at the moment of receiving an injury, greatly influence the degree of shock experienced. Anything that tends to weaken a patient increases the liability to shock, and thus hemorrhage, previous ill-health, certain forms of visceral disease, etc., are all found to have an unfavorable influence upon the results of operations by increasing the risk of shock. The most remarkable examples of the influence of surrounding circumstances are, however, seen on the field of battle: one man, moved by a sense of duty and heavy responsibility, will continue in the front, though he has received a severe and, perhaps, painful injury; while another, not necessarily a coward, may be completely unmanned by a comparatively slight scratch, and, forgetting everything else, cry like a child, or scream like a maniac.

Symptoms of Shock.—In a slight case of shock there may be merely a momentary, almost imperceptible, change of color, with a feeling of sinking in the precordial region, and perhaps slight qualmishness. In more marked cases there are evidences of great prostration; the patient lies helpless, and almost unable to move, the muscular relaxation affecting sometimes even the sphincters; the whole surface is very pale, even the lips appearing utterly bloodless; the skin seems shrunken, and the flesh softened; the surface is bathed in a cold sweat; the features are shrunken, the eyelids drooping, and the whole appearance is that of impending dissolution. The heart's action is always feeble, sometimes preternaturally slow and intermitting, but more usually fluttering and rapid; the pulse is commonly small and compressible, and in bad cases almost or altogether imperceptible. The respiration is feeble and gasping—sighing, as it is termed—or it may be so weak as scarcely to be noticed. There is often vertigo, dimness of vision, and slight deafness; though, on the other hand, there may be perfect mental clearness, and unnatural sensibility to light and sound. There may be various nervous manifestations, such as hiccough or subsultus, and in slighter cases, or during recovery from those which are more severe, there is frequently vomiting.

The *temperature* in cases of shock has been particularly investigated by Wagstaffe, who finds that a marked difference exists in the depression in temperature observed during collapse in fatal and in non-fatal cases. Thus, assuming the normal temperature to be 98.4° Fahr., a fall of 2° or more affords ground for a very gloomy prognosis. In exceptional cases, however, a very low temperature (91.2°) has been found compatible with recovery, and one still lower (81.75°) with existence.[1] According to Redard, who has also paid attention to this subject, if the temperature be below 35.5° Cent. (about 96° Fahr.), the injury will almost certainly prove fatal, and no operation should be performed; while in any case in which reaction as regards temperature is not observed within four hours from the moment of injury, the prognosis must be considered unfavorable.

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[1] Nicolaysen reports a case in which, from exposure to cold, the temperature fell to 76.4° Fahr., and yet the patient recovered.

When *death* occurs directly from shock, it is from the heart ceasing to act; post-mortem examination shows the heart (especially the cavities of the right side) and the great venous trunks distended with blood, which is sometimes fluid, and always coagulates with difficulty. In *recovery from shock*, the patient passes through the stage of *reaction;* the pulse gradually becomes stronger and more regular, the respiration grows deeper, and, after a few profound sighs, is perhaps fully re-established, vomiting often occurs, the temperature rises, the color improves, and the patient, from lying on his back, turns to one or the other side. The stage of reaction often passes too far, a feverish condition being developed, with great mental excitement, constituting *Traumatic Delirium* (see page 137), or the reaction may be incomplete, and that state come on to which Travers gave the name of "*prostration with excitement.*" There seems to be no definite relation between the different stages of shock, as to their duration and severity. The first stage, or that of depression, may be so slight, and last so short a time, as to escape observation, the stage of excitement, accompanied sometimes by the wildest delirium, being the first that attracts the surgeon's attention. Curious cases illustrating this statement may be found in works on military surgery, and it is suggested by Longmore, Legouest, and others, that the state of great excitement in which a soldier in action naturally must be, may probably determine the occurrence of these phenomena.

When shock proves directly fatal, it is, as has been said, through the heart that death occurs. Shock may, however, be complicated with other conditions, the result of the local effects of injury, the symptoms of which may gradually supersede those proper to shock, and life may thus be extinguished in other ways. Thus there may be concussion of the brain or spine coexisting with shock; or an important viscus, such as the liver, may have undergone laceration, when death may occur before reaction, and yet not from shock, but from internal hemorrhage or incipient peritonitis.

Treatment of Shock.—The object of the surgeon in managing a patient suffering from shock is, of course, to bring about reaction. As death from shock depends on the heart ceasing to act, the treatment must be directed to increasing the force and the regularity of the cardiac pulsations, and, in some few cases, this may perhaps best be done, as pointed out by Mr. Savory, by resorting to venesection. It is known that after death from shock the heart is filled with blood, and is, in fact, paralyzed from distention; it is known, from experiments on the lower animals, that in such a condition, even after all pulsation has ceased, the heart's action can be restored by mechanically relieving the organ by a puncture in the right auricle, or in the jugular vein; hence the inference is reasonable, and is confirmed by experience, that when —as in shock—death is imminent from engorgement of the right side of the heart and venous trunks, relief may be afforded by bloodletting. To make this as effective as possible, the blood should be drawn from the jugular vein. It is, of course, only in extreme cases, and in such as have not already suffered from hemorrhage, that this mode of treatment can be required, and it should be looked upon as an extreme remedy.

In all cases of shock, stimulation, both internal and external, should be employed. Dry heat is to be applied to the surface by means of hot bottles, hot bricks, etc.; sinapisms may be placed on the abdomen and chest, and cordial draughts administered if the patient be able to swallow, and if not, stimulating enemata resorted to instead. The general treatment of this condition has been already referred to in Chapter III., in discussing shock as a cause of death after operation, and I will merely repeat here that the arterial stimulants administered should be preferably such as are evanescent in their effects, as the preparations of ammonia; though in any severe case the use of brandy will be found essential, and, indeed, is often retained by the stomach better than anything else. Subcutaneous injections of ether may be employed with the greatest advantage. As during the stage of depression, absorption is greatly impeded, if not altogether checked, it is idle to give food until at least partial reaction has occurred, and even then it should be given with caution, and in small quantities at a time. For the same reason, opium, which is an invaluable remedy in these cases, is more effective when given hypodermically than by either the mouth or rectum.

In any case, as long as the heart's action continues, there is hope; and if natural breathing fail, artificial respiration should be resorted to, and continued systematically and perseveringly. Electricity is often used to excite the heart to renewed activity, but, at least in my own experience, without much benefit. Easley, of Little Rock, Ark., and McGuire, of Richmond, Va., recommend large doses of quinia, before operations, as a *prophylactic* against shock, while the same remedy, in combination with the camphorated tincture of opium, is employed in the form of enema by Lund, of Manchester.

Traumatic Delirium.—When *reaction* occurs, it is often excessive. In the treatment of *Traumatic Delirium* (p. 136), the surgeon must keep in mind that he is dealing with increased *action*, not with increased *power*. In fact, this condition always approaches more or less to Travers's "*prostration with excitement*," though the degree of debility of course varies in different cases. The symptoms of Traumatic Delirium are very much those of the ordinary *Delirium Tremens*, and indeed, in the case of hospital patients, many of whom are habitually hard drinkers, it is often quite impossible to draw an exact line, and say which condition is actually present. There are the same brightness of eye, heat of head, slight acceleration of pulse, constant and irrepressible muscular action, and sleeplessness with wandering delirium and rapid succession of spectral delusions, usually of a frightful and painful character. I do not believe that depletion is ever necessary in cases of pure traumatic delirium; if complicated with cerebral inflammation, the case may be different, but this is a question which will be referred to in its proper place. The head should be slightly elevated and kept cool by means of ice-bags, or Petitgand's apparatus (Fig. 7), and the patient kept as quiet as possible, in a rather dark room; as there is usually constipation with a furred tongue, a mercurial cathartic may be given, though profuse purging should be avoided. An anodyne and diaphoretic mixture will almost always be proper, to which, if there be great cerebral excitement, small doses of tartarized antimony may perhaps be cautiously added. The most important remedy in the treatment of traumatic delirium is *opium*, which should be given freely, and with brandy or whiskey in quantities proportioned to the debility of the patient. Food is quite as important as medicine, and should be regularly administered in a concentrated form, in small quantities at frequent intervals.

Amputation during Shock.—Before leaving the subject of shock, there is one question which demands consideration, which is, whether or no an amputation should be performed during the continuance of this condition. As a general rule there can be no doubt that it is right to wait for reaction to occur, before subjecting the patient to the additional source of depression which must come from the operation, and in any case it would be proper to wait a short time and endeavor to procure reaction in the way that has been directed. In some instances, however, especially in the cases of compound fracture produced by railroad or machinery, the mangled limb seems by its presence to act as a continual source of depression, and in such cases prompt amputation, even during the existence of a certain amount of shock, will give the patient a better chance than delay. Particularly is this the case when the injured part is very painful, and when bleeding is going on from small vessels that cannot be controlled. Under these circumstances it is a good plan to try the effect of anæsthesia; if the inhalation of ether produces an amendment in the patient's condition, making the pulse fuller and stronger, it is probable that the depression is purely one of shock from the external injury, and the surgeon will be justified in resorting to immediate operation. If, on the other hand, in spite of the anodyne and stimulating effect of the anæsthetic, the patient continue to sink, there is grave reason to apprehend that some severe visceral lesion is superadded to the obvious external injury, and under such circumstances operative interference will not be advisable. The surgeon may be aided in coming to a decision under these circumstances by observing the *temperature* of the patient; if this be below 96° Fahr., no operation as a rule is admissible (see p. 135).

Remote Constitutional Effects of Injuries.—These are even more obscure than those effects which are immediately produced. The state of system to which the older writers gave the name of *secondary* or *insidious shock* has already been referred to (p. 67). It is probably due, at least in the majority of cases, to the formation of coagula either in the heart itself or in the great venous trunks; this is a very fatal condition, and not unfrequently causes death after operations. Heart clots may kill the patient directly, by mechanically impeding the cardiac action, or portions of a clot may become detached and be carried by the circulation into other parts of the body, where they may prove fatal by plugging important vessels, such as the branches of the pulmonary artery, the internal carotids, etc. This process is called *embolism*, and the fragments of clot are called *emboli* or *embola*. Embolism by particles of *fat*, is an occasional cause of sudden death in cases of injury to the bones involving the marrow, as pointed out by Wagner, Busch, Czerny, Boettcher, Déjérine, Duret, and other surgeons; and a remarkable case of embolism of the pulmonary artery by a portion of the *liver*, following rupture of that organ, has been reported by Marshall, of Nottingham. Fat-embolism from rupture of a fatty liver, has been noted by Hamilton, of Edinburgh, and from a simple flesh wound of the thigh, by Dr. W. H. Bailey, of New York.

There are other obscure constitutional conditions which result from injuries, often probably through secondary lesions of the central nervous system. In other cases, again, from some local change, the general nutrition of the body may be affected through the medium of the blood. The *neuralgic* condition which sometimes follows injuries, and which has been particularly studied by Verneuil, may often be relieved by large doses of quinia.

LOCAL EFFECTS OF INJURIES.

These may be classified as the effects of violence, embracing contusions, wounds, fractures, and dislocations, and the effects of chemical agents (especially heat and cold), embracing burns, scalds, frostbite, etc. There are likewise certain remote local effects of injuries, which have not as yet been thoroughly traced out; thus many chronic affections of bones and joints originate from injuries, while external violence must be considered as at least the exciting cause of the development of many morbid growths, whether innocent or malignant.

Contusions.—In a contusion the skin is not broken. There is always, however, laceration of the subcutaneous tissues, sometimes very slight, as in the ordinary *bruise*, but sometimes causing complete disorganization of a limb or other portion of the body. When all the tissues of a part are completely crushed, it is sometimes said to be *pulpefied*. The skin itself, though not broken, may be so much injured as to lose its vitality, and slough. Every contusion is attended with more or less *extravasation* of blood; if in small amount, this constitutes *ecchymosis*, the blood undergoing certain changes in the process of absorption, which gives rise to the "black and blue" appearance of an ordinary bruise. If the extravasation of blood be in larger amount, it constitutes a *thrombus* (when clotted), or a *hæmatoma* when remaining as a tumor containing fluid blood. Beside the extravasation of blood, a contusion is always accompanied by the exudation of a serous fluid; this may be very slight and superficial, as seen in the wheal or elevated ridge produced by the stroke of a whip, or it may arise from deep-seated injury, when it makes its appearance in the form of vesicles and bullæ, as is especially seen in parts in which the bones are subcutaneous, as over the tibia and ulna. The subcutaneous hemorrhage or extravasation which accompanies a contusion is seldom productive of serious consequences, unless from rupture of a large artery. Mr. Erichsen has, however, recorded an autopsy in the case of a boy beaten to death by his schoolmaster, in which the fatal issue appeared to have been principally due to this cause. The amount of extravasation varies with the part affected; where the areolar tissue is of loose structure, as in the eyelids, it is very great, and the swelling correspondingly well marked. The *causes* of contusion are simple pressure, blows, and falls, or, in other words, direct and indirect violence. The *symptoms* are local pain and tenderness; swelling (from extravasation and exudation), preceded perhaps by a temporary depression or indentation from the force of the blow; momentary loss of color, followed by increased redness, and subsequently by various modifications of hue owing to the changes in the extravasated blood; increase of temperature, etc. In cases of severe contusion, vesications make their appearance in the course of from twelve to twenty-four hours, and by their size and number indicate the extent of subcutaneous injury. The *diagnosis* of contusion is usually easy. In some cases, however, the appearances are almost identical with those of incipient traumatic gangrene (which may indeed result from contusion), and then the nature of the case must be determined by negative evidence, by the absence of the characteristic gangrenous odor, by the temperature of the affected part, the constitutional symptoms, etc. In some situations, as in the scalp, difficulty of diagnosis arises on account of the extravasation, which in this position imparts to the surgeon's fingers very much the sensation of a depressed fracture. There is a ring of hard tissue with a soft central depression, which often deceives the hasty observer; by firm pressure the bone can be usually felt in its natural position, at the bottom of this depression, and the surrounding hard tissue may be observed to be really elevated above the normal level. A *thrombus* is sometimes mistaken for a solid tumor, and a *hæmatoma* for an abscess; the diagnosis under these circumstances must be made from the history of the case, from the absence of inflammatory symptoms, etc. Though extravasated blood is usually absorbed, it occasionally becomes encysted, remaining fluid for an indefinite period and thus becoming a starting-point for the development of a tumor, or it may coagulate and remain as a clot, or after coagulation become again liquid (Baker, *St. Bartholomew's Hosp. Reports*, vol. ii., pp. 201–223); according to Paget and others, the blood extravasated in contusion may actually become organized, acquiring more or less the characters of connective tissue, but it more frequently acts as a foreign body, exciting inflammation around, and being eventually discharged with the products of the resulting suppuration. The *prognosis* of contusion, unless some vital organ be involved, is usually very favorable. Provided that the skin be uninjured, the severest laceration will commonly be recovered from without difficulty; but if the atmosphere be admitted to the injured tissues by the smallest wound, or by secondary sloughing of the skin, the characters of a subcutaneous injury are lost, and wide destruction of parts may ensue. Contusions of bones and joints, and of nerves, are, as we shall see hereafter, often followed by secondary consequences of the gravest nature.

The *treatment* of ordinary bruises is best conducted by the application of slightly stimulating embrocations, such as the soap liniment of the Pharmacopœia, the tincture of arnica, or simply diluted alcohol. The absorption of extravasated blood may be assisted by gentle friction or kneading—a mode of treatment which the French have systematized under the name of *massage*. In severer cases, the part should be wrapped in some warm and soothing dressing, such as lint soaked in oil, with laudanum, or in lead-water and laudanum, in order to keep up the natural temperature, and prevent, if possible, the occurrence of gangrene. All tight bandaging or firm pressure should be strictly avoided. If gangrene should occur, the question of amputation may arise, and should be decided on the principles laid down in Chapter V.

If a thrombus form, the surgeon may endeavor to promote its absorption by moderate pressure and gentle friction; all rough handling should be avoided, lest suppuration be induced. In case of a collection of fluid blood persisting in spite of treatment, a puncture may be made, and, after the escape of the blood, pressure employed, with a view of inducing the walls of the cavity to adhere; if this fail, or if suppuration occur, a free opening must be made, and the case treated as one of ordinary abscess.

Strangulation of Parts.—Somewhat analogous to the condition of a part which has been severely contused, is that of a part which has undergone strangulation, from the pressure of a tight bandage or other cause of constriction. Strangulation is often intentionally employed by the surgeon in the treatment of various affections, such as nævus, vascular tumors, hemorrhoids, etc. In such cases the strangulated part becomes mortified, and is removed by the formation of granulations in the line of constriction. The fingers occasionally become accidentally strangulated by being carelessly thrust into tight rings. The ring can generally be removed by soaking the finger in iced water, which causes the part to shrink, or by the use of a silk cord, tightly wrapped around the finger and slipped under the ring, which is then worked off in the process of unwrapping. If these expedients do not avail, a director should be insinuated under the ring, which must then be divided be a file or by cutting-pliers. The penis is sometimes strangulated, either by being introduced into a ring, or, as has occasionally happened in the case of children, by the nurse tying a tape around the organ to prevent the child from wetting its bed. Unless the constriction be promptly removed, the most serious consequences will probably ensue, sloughing of the part being almost inevitable, and even death having occasionally followed this accident.

WOUNDS.

A wound is a division or solution of continuity of the soft tissues, produced by violence; an *open wound* is one in which the division of the skin is as free or nearly so as that of the deeper tissues, while a *subcutaneous wound* is one in which the opening in the skin is comparatively very small. Wounds are further classified by surgeons, according to their nature and causes, into *incised*, *lacerated*, *contused*, *punctured*, and *poisoned* wounds. *Gun-shot wounds*, and the peculiar form of injury known as *brush-burn*, are varieties of contused wounds.

Incised Wounds.—As its name implies, an incised wound is one made by a clean cut with a knife, razor, or other sharp instrument. These wounds are constantly intentionally inflicted by the surgeon, in amputating limbs, removing tumors, cutting for stone, etc. They are also frequently produced by accident, from the careless use of penknives or razors, or, among farm-laborers, from that of scythes or axes; many of the wounds produced by broken glass are incised, though these may also partake of the nature of lacerated wounds; the cut-throat of the suicide is an incised wound; the sabre-cuts met with in war, being inflicted with a heavy blow, approach to the nature of contused wounds. The *pain* of an incised wound varies according to the nature of the instrument with which it is inflicted, the part in which it is situated, and the manner in which it is produced. The sharper the knife, the less the suffering which it causes; wounds of the face or hands are more painful than those of the trunk; wounds made from within, less painful than those from without. The reason of these differences is very apparent: a clean cut with a sharp knife produces less dragging and tearing of sensitive parts than a haggling incision with a dull one; those parts which are most abundantly furnished with nerve filaments are most sensitive to pain; and by first dividing the trunks of nerves, their branches are paralyzed, and there will then be less suffering than under opposite circumstances; hence the advantage (before the days of anæsthesia) of the transfixion operation over other forms of amputation. It is well known that a wound rapidly inflicted is less painful than one more deliberately produced, and it has therefore been suggested by B. W. Richardson, and by Andrews, of Chicago, to use a blade connected with a rapidly revolving wheel, and it has been claimed that in this way operative surgery might be rendered painless; it seems to me, however, that such a contrivance would in practice be unmanageable, not to speak of the erroneous principle involved in its conception, which would endeavor to substitute mechanical ingenuity for the immediate personal attention and responsibility of the operator.

The amount of *hemorrhage* from an incised wound varies of course with the number and size of the vessels cut. Wounds of the face bleed more freely than those of the extremities, and wounds of the scalp are attended with very profuse hemorrhage, not only from the vascularity of the part, but because, on account of the denseness of the surrounding structures, there is not the same opportunity for contraction and retraction of the vessels, as in parts of looser texture. The existence of inflammation or other circumstances may cause the vessels of a part to be much enlarged; hence an incision into inflamed tissue will bleed more freely than one into normal structure. In some peculiar cases, in which what is called the *hemorrhagic diathesis* exists, the slightest wound—even that caused by lancing the gums of children—may cause fatal hemorrhage.

Beside the pain and bleeding which attend an incised wound, there is always more or less retraction of its edges or lips, which constitutes the *gaping* of the wound. The amount of this retraction depends upon the nature of the tissue involved, its condition at the time when the wound is inflicted, and the direction of the wound itself. Tissues which are elastic or which contain muscular fibres retract more than fibrous tissues; the following is given by Nélaton as the order in which the soft parts gape when wounded, viz., skin, elastic tissue, cellular tissue, arteries, muscles, fibrous tissues, nerves, cartilages. A wound of a part in which there is much tension, from inflammation or from any other cause, will gape more than one in the same part under ordinary circumstances. Thus an incision into an erysipelatous limb, or over the female breast during the process of lactation, will gape more than if those parts were not in a state of tension. Again, the direction of a wound affects the degree of retraction of its lips; an incision in the direction of the muscular fibres of a part will gape less than one which crosses that direction at right angles, and in general terms we may say that longitudinal wounds gape less than those which are transverse.

Process of Healing in Incised Wounds.—Incised wounds may heal in one of three ways, or, as more frequently happens, partly in one and partly in another of the three. The modes in which incised wounds heal are—1, *by immediate union*, or *by the first intention;* 2, *by adhesion;* and 3, *by granulation*, or *by the second intention*. Healing *by scabbing*, or *incrustation*, is a variety of the first or second methods, according to circumstances; while the so-called *secondary adhesion* (*third intention*, or *union of granulations*), is a mere modification of the third method—the union by granulation, or by the second intention.

1. *Immediate Union, or Union by the First Intention* (Hunter).—To understand the processes concerned in the healing of wounds, the reader must bear in mind what was said in the first chapter as to the *nutritive* and *formative changes* due to the inflammatory process. It is by means of these changes that the repair of wounds is in every instance effected. For a short time, varying from a few minutes to an hour or two, after the reception of a wound, it remains inactive; its edges then become somewhat red, warm, swollen, and painful—it has, in fact, become the seat of the inflammatory process. Now, if the wound be a clean cut, if it contain no foreign body nor clotted blood, if its lips be in close and accurate approximation, and if the tissues concerned be homogeneous (that is, if skin be apposed to skin, cellular tissue to cellular tissue, etc.), under the most favorable circumstances of general health and hygienic surroundings, the inflammatory process may stop in its first stage, that of *temporary hypertrophy*. The parenchyma in both lips of the wound is distended with nutritive material, a few wandering cells perhaps pass across the line of incision, the apposed surfaces adhere together, and the wound is healed by *immediate union*, or the *first intention*, without the formation of lymph, and, of course, without any resulting scar. This mode of healing is very seldom met with, at least in this country. I believe that I have seen it in cases of very slight cuts of the fingers, inflicted by the sharp blade of a penknife, and once in the face, in at least a portion of a clean incised wound. Sir James Paget has seen this mode of union in a case of excision of the breast. The cases which we read of every day in the journals, of union by first intention after amputation, are, I believe, really instances of the second method by which wounds heal, that by adhesion.

2. *Union by Adhesion.*—In the accomplishment of this process, the inflammation reaches its second stage, or that which is accompanied by the first formative change, viz., lymph production. This is what Paget calls union by adhesion (the name which I have adopted), or by adhesive inflammation—that distinguished surgeon and pathologist considering that the first mode of union is accomplished without any inflammation whatever; it is, however, I think, more consonant with the modern views of the inflammatory process, to look upon that process as necessary for the repair of wounds under all circumstances, and to regard immediate union, as I have done, as effected by inflammation limited to its first stage, that of temporary hypertrophy without lymph production. For union by the mode which we are now considering, lymph is essential. Whether this lymph be the result of cell proliferation, or whether it originate in the escape of white blood cells from the vessels, can-

not at present be considered as determined; in its appearances, physical properties, and other characters, it is identical with the inflammatory lymph described in Chapter I. To obtain union by adhesion, the patient must be in good condition, the wound healthy, and containing no foreign body or blood, its lips not bruised or otherwise injured, but accurately adjusted, and the cut surfaces strictly in apposition and excluded from the air. The inflammation must not pass beyond its second stage, or this form of union cannot be obtained. Perhaps the fairest examples of this mode of healing are to be seen in cases of plastic operation, as for harelip, lacerated perineum, etc. It is possible that in these cases immediate union may be sometimes obtained, but the presence of a slight scar after healing shows that, at least in the immense majority of cases, the union has been by adhesion or through the medium of lymph. Union by adhesion should always be aimed at in the treatment of stumps and of most operation wounds, and may be generally secured throughout the greater part of the incision. Scalp wounds, and wounds of the face and neck, commonly unite in this way, as do also, though more rarely, incised wounds of other parts of the body.

Superficial wounds, when their edges are brought together, often unite without difficulty under a scab, formed by the hardening, over the line of incision, of effused blood and serum, intermingled with hair, dust, and other foreign particles; the healing under such circumstances may be by immediate union, though it is more often by adhesion. In either case, this healing under a scab constitutes what has been called *healing by scabbing*, by *incrustation*, or by *subcrustaceous cicatrization*. It is a mere variety of one or other of the methods already described. Some confusion is often created by the application of the phrase "*union by the first intention*," by modern writers, to that process which I have described under the name, proposed by Paget, of "*union by adhesion*." The latter name is, I think, more correct, and more expressive of the process which actually occurs in the ordinary primary union of wounds, and the term "*first intention*" should, I think, be reserved for those rare cases of immediate union without lymph, to which it was applied by the illustrious John Hunter, though that surgeon erroneously believed that the union in such cases depended on the organization of an interposed layer of effused blood.

3. *Union by Granulation, or by the Second Intention.*—In this mode of healing, the inflammatory process reaches its third stage, that attended by the second formative change, or the production of pus. The cut surfaces become covered with granulations, precisely identical in structure and characters to those met with in a healing ulcer (see page 47), and the free surface is bathed with pus. The granulations gradually fill up the gap, and, when they have reached the level of the surrounding skin, cicatrization occurs just as in the repair of ulceration, which has already been fully described. The union by *secondary adhesion*, or by the *third intention*, is identical with the mode of union now under consideration, except that the granulating surfaces are so apposed that they unite and grow together, thus expediting the healing process. Union by granulation is that commonly met with in large wounds, such as those produced by amputation, or where, from excessive inflammation, from a large number of ligatures acting as foreign bodies, or from other causes, union by adhesion cannot be obtained.[1]

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[1] D. J. Hamilton, of Edinburgh, has recently advanced an ingenious theory, according to which the *lymph* which is found on the surface of a recent wound is an exudation from the divided lymphatic vessels, acts merely mechanically in favoring the adhesion of the cut surfaces, and is soon reabsorbed; the *repair* of the wound is due exclusively to proliferation of the connective-tissue corpuscles in its immediate vicinity; while the leucocytes, which escape from the bloodvessels, act as foreign

Treatment of Incised Wounds.—The object of the surgeon, in the management of every incised wound, should be to obtain, if not immediate union, at least union by adhesion. The credit of establishing the rule which is now universal, at least in England and in this country, to attempt to get primary union whenever possible, is due, in great measure, to the teachings of the British surgeons of the last century, especially Sharp, Alanson, Hey, the Bells, and Hunter, although it is probable that such a course was occasionally pursued in much earlier times. Its advantages are obvious; not only is the time occupied by the healing process much shorter when adhesion is obtained than when union occurs by granulation, and the resulting scar less conspicuous and disfiguring, but the patient is saved the exhausting consequences of prolonged suppuration, and is, in a great measure, preserved from the risk of the secondary affections which often complicate wounds, such as erysipelas, various forms of blood poisoning, etc. In making the attempt to procure primary union, there are three principal indications presented to the surgeon; these are (1) to arrest and prevent hemorrhage, (2) to remove all foreign substances, and (3) by suitable dressings to adjust the cut surfaces closely and accurately, to prevent the access of atmospheric air, and to prevent the inflammatory process from passing beyond its second stage, or that of lymph formation.

(1.) If the *hemorrhage* be of the nature of general oozing from small vessels, it may be commonly controlled by position, or by the use of cold, of pressure, or of various styptics, as will be described in another chapter; if the bleeding be from larger vessels, these must be treated by ligature, by acupressure, or by torsion, the comparative merits of which plans will be fully discussed when we come to speak of wounds of arteries.

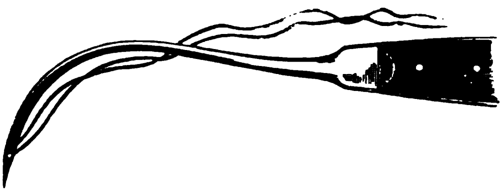
(2.) Hemorrhage having ceased, the surgeon must carefully but gently cleanse the wound, so as to remove all *foreign substances* which may have lodged between its lips. This may be conveniently done by means of a stream of running water (as supplied by the "ward carriage," Fig. 10); or if sponges be used they should be new and soft, and very gently handled. As Sir James Paget well puts it, "Wounds should not be scrubbed, even with sponges." Mr. Callender employed camel's-hair brushes. To determine the freedom of a wound from foreign bodies, the surgeon may put in service his hands as well as his eyes, it being sometimes possible to detect with the finger a grain of sand or spicula of bone, which, embedded in muscle and tinged with blood, might escape ocular observation.

(3.) *Dressing of Incised Wounds.*—As a rule, wounds should not be dressed until all oozing has ceased. A great deal used to be said about the *glazing* of a wound, and it was supposed that this glazing consisted in the exudation from the bloodvessels of a fibrinous material (lymph), which formed the bond of union. But whatever be the origin of this lymph (a question of purely theoretical interest), there is no reason to suppose that it is formed more readily or of a better quality, before than after the closing of a wound; hence, as soon as hemorrhage has ceased, the sooner the lips of the wound are approximated the better. In closing wounds, the surgeon makes use of sutures, plasters, and bandages. The various materials employed for sutures have

bodies, and are either reabsorbed or discharged as *pus*. According to the same writer, *granulations* are not new formations, but consist of capillaries which are distended into the form of loops on account of the removal of the restraining pressure of the integument. Hence, Mr. Hamilton regards what is known as union by granulation as really the same as union by adhesion. Mr. Hamilton also recommends, under the name of "sponge-grafting," the introduction into wounds, when there is much loss of substance, of a *carbolized sponge*, to act as a framework for the support of the granulations.

been already described in previous chapters, and it will be sufficient to say here, that, for ordinary purposes, lead or malleable iron wire is the most suitable and convenient. The *needles* used by surgeons are of various sizes and shapes, as shown in Fig. 38; it is occasionally advantageous to have a strong needle mounted in a handle (Fig. 68), and with an eye at its point, like the "nævus needle," for use in situations difficult of access, or when the tissues to be penetrated are unusually dense. Various needles have been devised for special use with wire, but present no particular advantages over those generally employed. The various forms of suture commonly used by the surgeon may be enumerated as the *interrupted suture*, the *continued* or *glover's suture*, the *twisted* or *harelip suture*, and the *quilled suture*.

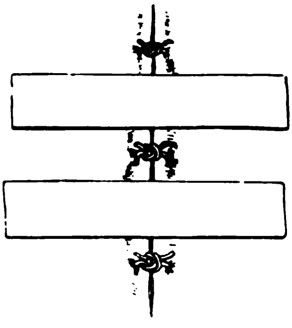
FIG. 68.



Mounted needle, armed with a ligature.

The *interrupted suture* (Fig. 69), which is that most frequently used, consists, as its name implies, in a number of single stitches, each of which is entirely independent of those on either side. In applying it, the surgeon holds one lip of the wound with the fingers of the left hand, or with forceps, and introduces, with a quick thrust, the needle previously threaded, about two lines from the cut edge; he then takes the opposite lip in the same way, and passes the needle, in this case from within outwards, taking care that there shall be no undue tension or uneven dragging of the wound. Some surgeons employ two needles, passing both from within outwards; but this causes unnecessary delay, and offers no advantage over the common mode. Each stitch may be secured as it is introduced, or all may be passed, their ends being left loose to be fastened subsequently. If silk be employed, it is tied in a reef-knot; if wire, it is simply twisted. If the mounted needle (Fig. 68) be employed, it must be thrust through both lips of the wound before being threaded (the suture being thus passed as it is withdrawn), and must, therefore, be re-threaded for each stitch.

FIG. 69.



The interrupted suture.

The distance between the points of the interrupted suture, and the depth to which each stitch is passed, vary with the nature and extent of the wound; as a rule, the skin and superficial fascia only should be included in the stitches, and there should be an interval of from half an inch to an inch between the consecutive points of introduction.

The *continued* or *glover's suture* (Fig. 70) is principally used for wounds of the intestines, though it is occasionally employed in other situations where the tissues are of loose structure, as in the eyelids. It is made with silk or with a fine thread, which passes across the wound continually in the same direction; it is the stitch employed in the manufacture of gloves, whence it derives its name.

The *twisted* or *harelip suture* (Fig. 71) is an excellent method of uniting

Treatment of Incised Wounds.—The object of the surgeon, in the management of every incised wound, should be to obtain, if not immediate union, at least union by adhesion. The credit of establishing the rule which is now universal, at least in England and in this country, to attempt to get primary union whenever possible, is due, in great measure, to the teachings of the British surgeons of the last century, especially Sharp, Alanson, Hey, the Bells, and Hunter, although it is probable that such a course was occasionally pursued in much earlier times. Its advantages are obvious; not only is the time occupied by the healing process much shorter when adhesion is obtained than when union occurs by granulation, and the resulting scar less conspicuous and disfiguring, but the patient is saved the exhausting consequences of prolonged suppuration, and is, in a great measure, preserved from the risk of the secondary affections which often complicate wounds, such as erysipelas, various forms of blood poisoning, etc. In making the attempt to procure primary union, there are three principal indications presented to the surgeon; these are (1) to arrest and prevent hemorrhage, (2) to remove all foreign substances, and (3) by suitable dressings to adjust the cut surfaces closely and accurately, to prevent the access of atmospheric air, and to prevent the inflammatory process from passing beyond its second stage, or that of lymph formation.

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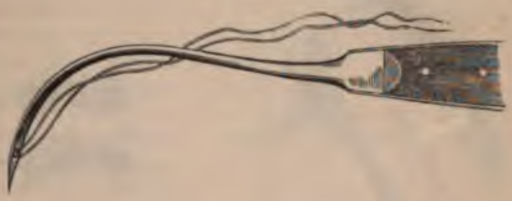

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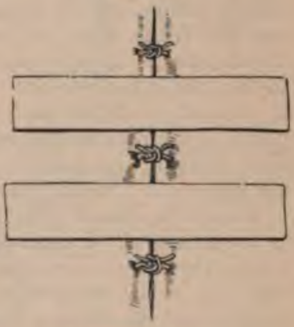

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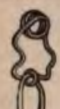
The *twisted* or *harelip suture* (Fig. 71) is an excellent method of uniting

Serre-fines (Fig. 74) may be used for slight and superficial wounds, either alone or in addition to other measures, when very close and accurate union is desired.

Sutures and plasters will only serve to approximate the edges of a wound; its deep surfaces should be brought into contact by the use of *compresses* (of lint, oakum, or charpie) and appropriate *bandages*. The bandage of Scultetus and other still more complicated devices were formerly much used by surgeons for this purpose, but are now almost universally supplanted by the common roller bandage, which in skilful hands can be made to meet every indication.

FIG. 74.



The serre-fine.

Ordinary incised wounds should be dressed as lightly as possible; a piece of lint, wet or dry, or an oiled or greased rag, held in place by a few strips of plaster or turns of a roller, will commonly be sufficient. Guérin, Warren Greene, and others commend the use of *cotton-wool*, which they believe acts as a filter to prevent the access of deleterious germs to the wound; and Hewson, of this city, has reported very favorably of the employment of *dry earth* as a primary dressing; while Prof. Hamilton, of New York, is equally enthusiastic in his praise of the continuous warm bath, a mode of treatment which, I believe, originated with Langenbeck, and which has been modified by Duplay, who plunges the limb in an "antiseptic bath" containing one per cent. of carbolic acid. In scalp wounds, it is generally right to apply a firm compress, so as to check oozing and prevent bagging of serous and other discharges. Sutures may be removed about the fourth or fifth day, or sooner if they have become loosened, and the edges of the wound should then be supported by strips of plaster till union is complete. If the wound become inflamed and painful, it must be treated on the principles laid down in previous chapters.

Lacerated and Contused Wounds.—These two varieties of wound may be considered together, as they generally coexist in the same cases, and require essentially the same treatment. As their names imply, a lacerated wound is one of which the edges are torn and not sharply cut, and a contused wound is one of which the edges are bruised. These wounds are inflicted by blows from dull instruments, as stones or clubs, by machinery accidents, by injuries from railway trains, etc. Gunshot wounds are likewise included under this head, but are of such importance as to demand a separate chapter for their consideration.

Lacerated and contused wounds present several peculiarities of character and appearance. Thus, their edges are irregular and jagged; the pain is duller and less acute, though more lasting, than that of incised wounds; there is less tendency to gaping, and there is less bleeding. This arises from the mouths of the vessels being twisted and crushed, rather than evenly divided. More or less sloughing always attends these wounds, and they are peculiarly liable to be followed by erysipelas, secondary hemorrhage, and tetanus. As a rule, and universally in this part of the world, lacerated and contused wounds heal only by granulation, or by second intention; in certain rare cases, however, and under peculiarly favorable climatic influences, it is said that they occasionally unite by adhesion. When a limb is entirely torn off from the rest of the body, the tissues of the part give way at different levels. The skin usually separates at the highest point; the muscles protrude, and appear to be tightly embraced and almost strangulated by the skin; the tendons,[1] vessels, and nerves hang out of the wound, of variable lengths, while the shattered bone forms the apex of the ragged conical stump. There is usually comparatively little hemorrhage under these circumstances, as in Cheselden's well-known case of avulsion of the whole upper extremity, but occasionally the bleeding is very profuse, and proves directly or indirectly fatal. In a case of this kind, in which a child's thigh, being caught between the spokes of a carriage-wheel, was torn off at the middle, I found the great sciatic nerve hanging fifteen inches from the stump, having given way below its division in the ham; a curious fact in this case was, that, while the cutaneous surface of the stump was acutely sensitive to the touch, there was no manifestation of pain evinced upon handling the exposed nerve.

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[1] In some cases the tendons give way at a point much higher than that at which the other tissues separate.

The principal danger attending lacerated and contused wounds, is the occurrence of gangrene. This may be of three kinds:—

(1.) Sloughing of the injured tissues, to a greater or less extent, may be considered inevitable in any severe lacerated or contused wound. This is the ordinary form of the affection, and demands no special consideration. The parts which have lost their vitality will be thrown off by the efforts of nature, and the wound will then heal by granulation, or, if the sloughing be extensive, amputation may be required.

(2.) There may be gangrene from arterial obstruction at a point above the apparent seat of injury; this form of gangrene is principally met with in cases of gunshot injury, and is often a cause for amputation (see page 92).

(3.) The most fatal form of gangrene is the true *traumatic or spreading gangrene*,[1] which is always of the moist variety, from implication of the venous system, and is usually met with in connection with severe compound fractures or other destructive lacerations produced by railway and machinery accidents. The most rapidly fatal case which I have ever seen was in the person of a professional lion tamer, whose thigh was frightfully lacerated by the teeth and claws of the animal with which he was in the habit of performing. Traumatic gangrene occasionally, however, follows comparatively slight local injuries, and this circumstance has led many authorities to attribute its occurrence to constitutional causes. Certain it is that those are especially apt to be attacked by traumatic gangrene who are in a depraved state of health, and particularly such patients as suffer from organic disease of the kidneys. The symptoms of traumatic gangrene are sufficiently characteristic. The limb swells and becomes tense, and a dusky-red or purplish color supervenes, attended with a deep-seated burning pain. Soon the dusky hue gives way to a dark mottled appearance, vesications and bullæ are formed, the surface becomes soft and boggy, and emphysematous crackling, running along the deep planes of cellular tissue, gives evidence of the formation of gases as the result of decomposition. Below the seat of gangrene, the limb has a cadaveric appearance, while above, œdema and discoloration rapidly extend, especially along the planes of areolar tissue on the inside of the limb, reaching and invading the trunk in perhaps a few hours from the period of commencement. While the gangrene spreads upwards, the part first attacked falls into the condition of a disorganized, black, and pultaceous mass. The general symptoms indicate from the first a state of extreme constitutional depression. Death is almost inevitable in these cases, and follows shortly after the gangrene has reached the trunk; or it may occur at an earlier period, as pointed out by Perrin, from gases entering the circulation and proving fatal, as when air enters the veins in an operation.

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[1] This grave affection has also been described under the names of *putrid pneumohæmia* (Maisonneuve), *bronzed erysipelas* (Velpeau), *gangrenous emphysema*, *traumatic poisoning* (Chassaignac), *acute purulent œdema* (Pirogoff), *acute putrid infection* (Perrin), and *acute gangrenous septicæmia* (Terrillon).

Treatment of Lacerated and Contused Wounds.—Small portions of the body, especially of the face, even if entirely separated, will occasionally reunite when replaced and carefully supported; hence, as a rule, all lacerated or partially detached flaps of tissue should be gently cleansed and readjusted, for even if sloughing eventually take place, the attempt to preserve the injured part will at least have been attended by no harm. Great caution should, however, be used in any case of lacerated or contused wound as to the employment of sutures. These wounds are always followed by a good deal of inflammation and consequent swelling, and if the parts be closely stitched up, there will probably be so much tension as seriously to endanger the vitality of the already bruised and torn tissues. I am confident that I have seen extensive sloughing of integument, due quite as much to the over-zealous use of sutures, in these cases, as to the effects of the original injury. A few stitches may be proper, if the wound be large and there be much tendency to gaping; but it is best to rely chiefly upon the support afforded by plaster and judicious bandaging. For lacerated wounds without much contusion, especially about the face, where the tissues are very vascular, cold water, or glycerine and water, is an excellent primary dressing; it may be applied simply by wetting pieces of lint, or by irrigation. When the edges of the wound are contused as well as lacerated, warm dressings are usually more grateful, and here warm water, or, still better, diluted alcohol or diluted laudanum, answers a very good purpose. Cotton-wool, dry earth, and the warm bath, are recommended by their respective advocates, as in the case of incised wounds. Chloral in solution (gr. v.–℥j.) is recommended by W. W. Keen, Marc Sée, and other surgeons. When the slough is about to separate, poultices, especially those containing yeast or porter, may be advantageously substituted for the alcoholic dressing, to be replaced in turn, when the wound is fairly granulating, by lime-water or such other substance as the appearance of the part or the fancy of the surgeon may dictate. At each dressing, disinfectants, such as the preparations of chlorine, dilute carbolic acid, or the permanganate of potassium, should be freely used; the latter agent is that which I am myself in the habit of employing, and it is certainly the most elegant of all the preparations that have been mentioned.

Amputation in Lacerated and Contused Wounds.—In many of the worst cases of lacerated and contused wound, no treatment will avail, short of removal of the injured limb. Thus, if an arm or leg be entirely torn away, or if all the soft parts and bones be crushed together into a pulp-like mass, there can be no question as to the propriety of amputation. Those cases, however, in which the soft tissues are alone involved, the bones escaping injury, present more difficulty; there is a popular notion that cases of this kind do not require amputation; it is a mere flesh wound, it is said, and the surgeon ought to be able to cure it. I am well convinced, however, that when the skin and muscles are extensively torn and separated, even if the bone be whole, especially in the lower extremity, amputation is more often necessary than is commonly supposed. It must be remembered that the appearance of the skin often gives an imperfect idea of the amount of injury beneath; I have not unfrequently found the skin apparently healthy and uninjured, when by insinuating the finger beneath the surface, all the deeper-seated tissues, muscles, vessels, and nerves, were found pulpefied, as it were, and crushed into an almost indistinguishable mass. If amputation be required, it should be done as soon as sufficient reaction has occurred; the advantages of primary over secondary amputation were fully considered in Chapter V., and need not be referred to here. If an attempt be made to save the limb, however, secondary amputation may become necessary from the occurrence of hemorrhage, or from the onset of one of the forms of gangrene described on page 149. If the true *traumatic gangrene* should occur, amputation must be at once performed, though the chances of a successful issue are, it must be confessed, under these circumstances, very doubtful. It is, perhaps, scarcely necessary to give the caution not to be deceived into amputating for a mere superficial slough, an error which can be avoided by carefully watching the case for a few hours, when, if mortification have really taken place, the occurrence of putrefactive changes in the part will sufficiently clear up the diagnosis. When amputation is resorted to under these circumstances, it should be done at a point sufficiently removed from the seat of gangrene, to avoid, if possible, the recurrence of disease in the stump.

Brush-burn is a name used by Mr. Erichsen for the form of contused wound which is produced by violent friction. It is frequently caused in manufacturing districts, by portions of the body being caught by rapidly revolving straps of leather or other material. Brush-burn may vary in severity from a mere superficial abrasion to absolute destruction of the skin and subjacent tissues. It is a very painful injury, but not dangerous, unless very extensive and severe, and it presents no peculiar indications. The part is to be protected from the air, the separation of sloughs promoted by poultices, etc., and the resulting ulcer treated on general principles.

Gunshot wounds will form the subject of the next chapter.

Antiseptic Treatment of Wounds.—Under the name of the "*antiseptic method*," Prof. Lister, formerly of Edinburgh, but now of King's College, London, has urged the employment of carbolic or phenic acid as a dressing in surgical cases, and the practice has, both in his hands and those of others, no doubt met with a large measure of success. At the same time, other surgeons equally competent and careful, and who have endeavored conscientiously to carry out Prof. Lister's instructions, have utterly failed in obtaining the promised results, while results quite as good as those of Prof. Lister's followers are obtained by surgeons who rely simply upon enforcing cleanliness and attending to the constitutional hygienic condition of their patients, without adopting any exclusive mode of dressing. Other substances, such as boracic and salicylic acids, thymol, etc., have been also employed, but carbolic acid is upon the whole preferred by Prof. Lister himself,[1] and by most of his disciples. The theory of the method is founded on the observations of Pasteur, and supposes that animal decomposition is due to the presence of organic germs floating in the atmosphere, and carbolic acid is used on account of its known destructive effects upon low forms of organic life.

To carry out the "antiseptic system" in dressing a wound or performing an operation, there are needed: two solutions of carbolic acid, one containing one part of the acid to forty of water, and the other one to twenty; an "atomizer," or steam-spray apparatus[2] (Fig. 75), with a very large flame produced by burning the vapor of alcohol—the solution of carbolic acid to be atomized containing one part to thirty, and being diluted by the steam to the strength of one to forty; a "protective," consisting of oiled silk covered on both sides with copal varnish, and then with a mixture of dextrine starch and carbolic acid; "antiseptic gauze," which is simply loose cotton-cloth thoroughly imbued with a mixture of one part of carbolic acid, five of paraffine, and seven of common resin;[3] Mackintosh cloth; drainage-tubes; carbolized silk sutures;

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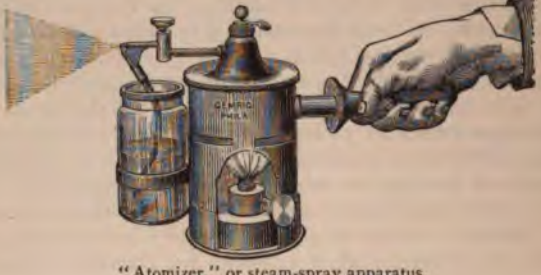
[1] In the *British Medical Journal* for May 28, 1881, Prof. Lister is reported to have said that he had found the oil of eucalyptus to be "a perfect substitute for carbolic acid."

[2] Richardson, of Dublin, has devised a spray-apparatus to be worked by the foot.

[3] Or, which Mr. Lister has since recommended, oil of eucalyptus, one part, dammar gum, three parts, and paraffine, three parts.

and carbolized catgut ligatures, made by soaking catgut in a mixture of carbolic acid, glycerine, chromic acid, alcohol, and water. If adhesive plaster is to be used, it is to be rendered antiseptic by dipping it in a hot solution of carbolic acid. All the instruments, sponges, drainage-tubes, etc., to be used, must be kept lying in the 1–40 solution of the acid; and if an instrument is laid down for an instant, it must be re-dipped before it is again employed.

FIG. 75.



"Atomizer," or steam-spray apparatus.

Before beginning an operation, the part is to be shaved, and thoroughly washed with the 1–20 solution of carbolic acid. (In the case of an accidental wound, this solution should be not only applied to the surface, but should also be carried into all the recesses of the wound.) The spray is then made to play over the part, and kept in action until the whole operation is completed; if the surgeon's hands, or those of his assistants, pass beyond the limits of the spray, they must be re-dipped in the 1–40 solution before again approaching the wound. All vessels are to be tied with the antiseptic catgut-ligatures, both ends of which are cut short, and the drainage-tubes are to be placed deeply in the wound and cut on an exact level with the surface,[1] being held in place by means of pieces of carbolized silk. The wound having been closed with the antiseptic sutures (and adhesive plaster, if necessary), a small piece of the "protective," dipped in the 1–40 solution, is applied, so as to protect the raw surface from the irritating effects of the remainder of the dressing. The wound is next covered with a layer of the "antiseptic gauze," dipped in the 1–40 solution, and there are then successively superimposed six layers of dry gauze, one of Mackintosh, an eighth layer of gauze, large enough to cover in all that have preceded, and finally a bandage of the same material. Whenever the dressings are changed, this is to be done under the spray, and special precaution is to be taken not to admit any uncarbolized air. The outer dressings are not changed until the discharge has begun to soak through, while the inner dressings may in some cases be allowed to remain for weeks without renewal.

As has been already indicated, the alleged superiority of the "antiseptic method" cannot be said to have been as yet demonstrated. Prof. Lister, though repeatedly challenged to do so, has not thought proper to publish any detailed statistical account of his results, and most of the reports which have come from other sources have been accounts of isolated cases, or of the general impressions of the writers.

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[1] Chiene, of Edinburgh, employs instead of the ordinary drainage-tubes, hanks of carbolized catgut, which act by capillary absorption and are finally dissolved in the discharges. McEwen, of Glasgow, employs decalcified chicken bones as drainage-tubes, steeping them in a solution of chromic or carbolic acid, and introducing them threaded with horsehair, which is withdrawn in a few days.

Failure on the part of other surgeons to attain the expected results, is attributed by the advocates of the plan to some mistake or neglect in the application; and such may doubtless be the case. But it is obvious that any mode of treatment which is so intricate and complicated as to elude the skill of such excellent surgeons as have failed with the antiseptic dressing, is not likely ever to be adapted for general employment.

Punctured Wounds.—These, as their name implies, are such wounds as are inflicted with the *point*, rather than with the *edge*, of a weapon. If the point be sharp, the wound approaches somewhat the character of an incised wound; if dull, the injury more resembles a contused wound. Punctured wounds are always painful, and are apt to be followed by a good deal of swelling and inflammation. If deep, and especially if they penetrate an important cavity, they are attended by much risk to life. The form of punctured wound most frequently met with in civil practice is that produced by the common sewing-needle, which easily penetrates the flesh, and then is broken off, the point remaining in the tissues. These wounds may be met with in any part of the body, but are, for obvious reasons, most often found in the hands, feet, knees, and buttocks. If the surgeon see such a case shortly after the introduction of the needle, he should, if possible, at once remove the foreign body. Its position can usually be detected, even if it cannot be seen, by a sensation of limited resistance offered to the surgeon's fingers on careful palpation. If it be necessary to cut down upon the needle (which operation may be much facilitated by using Esmarch's tube and bandage), the incision should be made somewhat obliquely to the position of the foreign body, so that it may be reached with suitable forceps a short distance below the point at which it is broken; it is occasionally more convenient to push the needle onwards, thus making its point emerge by a counter-opening at a little distance. If the case be not seen for some hours after the introduction of the needle, when swelling has already occurred, or if unskilful efforts at extraction have only served more deeply to imbed the foreign body, it is often impossible for the surgeon to satisfy himself as to the position of the needle. In such cases it is usually better to wait until the establishment of suppuration has dislodged the foreign body, when it will gradually work its way towards the surface. The presence or absence of a needle might, in case of doubt, be determined by the magnetic test of Mr. Marshall, holding a powerful magnet upon the part for fifteen or twenty minutes, so as to influence the fragment, the presence of which would then be revealed by the deflection of a polarized needle delicately suspended above it. Very serious consequences sometimes result from the prick of a needle; I have known necrosis of the entire shaft of the humerus, due to a wound of the periosteum thus inflicted. After the removal of the foreign body, cases of needle wound are to be treated on general principles. If an important part, such as the knee-joint, is involved, entire rest and the local use of dry cold will be particularly indicated.

Bayonet Wounds form almost the only class of punctured wounds now met with in civilized warfare. They are very rare, only 143 cases being recorded in Circular No. 6, S. G. O., 1865, compared with over 85,000 wounds of other descriptions; of these 143, only six proved fatal. Formerly, when duelling was very frequently resorted to by soldiers, the small-sword was the weapon usually employed, and punctured wounds were thus constantly inflicted; they were treated by the drummers of the regiment, who sucked the part dry from blood, and then applied a piece of chewed paper or wet cloth to the wound, which frequently healed under this treatment in a remarkably short space of time. This mode of practice is said by Percy and Laurent to have originated among the Romans (who employed suction as a remedy for poisoned wounds), and to have been introduced into military surgery by Cato, who would not allow doctors in his army, disliking them because they were usually of Grecian birth.

Arrow Wounds are frequently met with on our western border in conflicts with the Indians. They are very serious injuries, being particularly fatal when they involve the abdominal cavity. The following tables, taken from an excellent paper by Dr. J. H. Bill, in the *American Journal of the Medical Sciences* for October, 1862, show the relative fatality of arrow wounds in different parts of the body, and the causes of death in fatal cases:

	HEAD.				CHEST.			ABDOMEN.				
	Brain wounded.	Brain not wounded.	Spinal marrow.	Neck.	Lung wounded.	Lung not wounded.	Heart.	Intestine wounded.	Intestine not wounded.	Upper extremity.	Lower extremity.	Total.
No. of cases saved, .	1	2		2	2	9			3	27	5	51
No. of cases died, .	2		1		4		2	15	3[1]	1	1	29
Total, ...	5		1	2	15		2	21		28	6	80

Cause of death.	Immediate hemorrhage.	Peritonitis.	Compression of brain.	Wound of heart.	Empyema.	Tetanus.	Pneumonia.	Wound of spinal cord.	Other injuries.	Total.
Number of cases, . . .	7	13	2	2	1	1	1	1	1	29

Dr. Otis has, in Circular No. 3, S. G. O., 1871, published 83 additional cases of arrow wound, of which 26, including nearly all in which the great cavities of the body or the larger bones and joints were involved, proved fatal.

The great danger in cases of arrow wound is, as shown by Dr. Bill, from the head of the weapon becoming detached from the shaft, and remaining in the wound as a foreign body of the worst description. Hence the importance of not hastily pulling the shaft away while leaving the head, and the equal importance of careful but persistent efforts to remove the latter. This may often be done by catching the head of the arrow in a strong wire loop, as recommended by Dr. Bill, or it may be sometimes better to make a counter-opening, and in case of a chest wound, if necessary for this purpose, even to cut through the rib with a trephine.

It is commonly believed that the Indian tribes make use of poisoned arrows; it would appear, however, from the reports of Dr. Bill and other army surgeons, that in reality this is very seldom done; I am, however, informed by Dr. Schell, who was stationed for some time at Fort Laramie, that it is the universal custom to dip the arrows in blood, which is allowed to dry on them, and it is not improbable, therefore, that septic material may thus be occasionally inoculated through a wound.

Tooth Wounds.—Quite severe injuries are occasionally inflicted by *bites*, even when there is no evidence of the introduction of any morbid poison. Prof. Gross has met with cases in which great inflammation and suffering followed abrasions of the hand received in striking another person on the mouth, and I have myself seen a bite of the thumb followed by fatal tetanus.

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[1] One of these perished from a gunshot wound.

The *treatment of punctured wounds* consists in the use of simple anodyne dressings, and in the adoption of means to prevent the development of excessive inflammation.

Poisoned Wounds.—The *Stings of Insects* are seldom productive of serious consequences, in this country at least. In tropical climates, the insects appear to be more venomous, and, according to the reports of African and other travellers, death not unfrequently results from such a cause. Even in this part of the world, however, death, sometimes preceded by gangrene, has occasionally resulted from the sting of a bee or the bite of a mosquito, probably owing to idiosyncrasy on the part of the patient. The pain of a sting may be relieved by the application of spirit of hartshorn (aqua ammoniæ), and the subsequent inflammation should be treated on general principles.

Snake Bites are often productive of serious symptoms, and not unfrequently of death. All snakes, however, are not venomous; and even in the case of those which are known to be poisonous, if by the action of biting a few times they have exhausted their stock of venom (which in the instance of the rattlesnake is contained in a small pouch under the upper jaw), the wounds which they can then inflict, until the venom re-accumulates, may be no more serious than other punctured wounds of similar characters.

The bite of the rattlesnake is usually attended with much pain, though this is not always the case; there is sometimes free external bleeding, and always rapid interstitial hemorrhage, causing great swelling of the affected part, which is usually one or other extremity. In cases which terminate unfavorably, the swelling rapidly ascends the limb, which is deeply discolored; vesications make their appearance, and the part falls into a gangrenous condition. In favorable cases, the swelling and other local symptoms disappear almost as rapidly as they came. The constitutional symptoms of rattlesnake poisoning are those of extreme prostration, the mind often remaining clear until within a few minutes of the fatal issue. Death may take place in a very short time (forty minutes only in a case reported by Dr. Shapleigh), from the direct effect of the poison on the nervous system, or after the lapse of several days or weeks, from extensive sloughing and suppuration resulting from the local injury. The coagulability of the blood appears to be much impaired by the effect of the poison, this fact accounting for the great interstitial hemorrhage, and consequent swelling and discoloration.

Various substances have been proposed as antidotes to snake poison, those which have attained most reputation being the *eau de luce* (containing ammonia), the Tanjore pill (of which arsenic is a principal ingredient), Bibron's antidote (containing corrosive sublimate, bromine, and iodide of potassium), and the liquor potassæ, recommended by Dr. John Shortt. Prof. Halford, of Australia, has proposed the direct injection into the veins of dilute aqua ammoniæ, and has reported several cases in which the treatment was followed by recovery. The use of ammonia in this way might doubtless prove efficient as a cardiac stimulant, but the treatment has completely failed in the hands of Prof. Fayrer, and there seems to have been a doubt as to the venomous nature of the snakes, in some of those cases in which success followed the use of the remedy. The hypodermic use of ammonia has been successfully resorted to by Dr. Semple, in a case of *spider bite* attended with grave symptoms, and by Dr. Elder in four cases of poisoning by the bite of the *copperhead* or *red viper*.

There is no evidence of advantage from the use of any of the antidotes above mentioned in cases of rattlesnake poisoning; the remedy attributed to Prof. Bibron, which was highly esteemed a few years ago, is now, I believe, abandoned even by those who most highly extolled its virtues. The treatment recommended by Dr. S. W. Mitchell, who is one of the highest living authorities on this subject, consists in the internal administration of alcoholic stimulus, of course not pushed to the point of producing deep intoxication, with suction by means of a cupping-glass, the application of carbolic acid, diluted with half its weight of alcohol, and the local use of the *intermittent ligature*. The intermittent ligature consists of a tourniquet applied above the injured part, so as to interrupt the blood current, except when momentarily relaxed by the surgeon; by the use of this means a small portion of the venom can be admitted at a time into the general circulation, and the enemy, as it were, met and fought in detachments. The warmth of the body should be kept up to the normal standard, by the use of external heat; and, should it be found impossible to produce sufficient stimulation through the stomach, the inhalation of the fumes of warm alcohol, or even of ether, might be resorted to.

Fayrer recommends in the treatment of wounds inflicted by the cobra, or by other poisonous serpents of India, the application of a tight ligature, with amputation, excision, or cauterization of the part, followed by the internal administration of hot spirits and water, which he considers preferable to ammonia, and by the use of external heat, galvanism, and perhaps the cold douche. Should the breathing fail, artificial respiration should be resorted to, in hope that life may be thus prolonged until elimination of the poison has been effected.

Bites of Rabid Animals, especially cats, dogs, and, according to Drs. Janeway and Wolf, skunks, sometimes prove fatal through the occurrence of *Hydrophobia*. The peculiar poison which produces this frightful affection appears to be communicated by means of the saliva, though whether it originate in that secretion or be merely mixed with it, coming from other structures of the mouth, is uncertain. The proportion of cases of hydrophobia to the number of persons bitten by dogs or other animals supposed to be mad, is very small, only 71 deaths from this affection having occurred in London in twenty-nine years, an annual average of less than 2½. After the reception of a bite, the poison may remain latent for a variable period, the limits of which have been placed at as short a time as one day, and at an interval as long as forty years. The truth appears to be that the stage of incubation may vary from about four weeks to eleven months, sometimes, however, undoubtedly surpassing the latter limit. This difference is supposed, by Mr. Forster, to depend on the part bitten, and the circumstances under which the bite is received. If the face be the seat of injury, the period of latency will probably not exceed four or five weeks, and if the disease have not appeared in that time, the patient may be considered safe. When the hand is the part affected, the period of latency varies from five weeks to a year; and when the clothes have been bitten through before the skin is injured, several years may elapse before the development of the disease. An apparently authentic case has been recently reported by Féreol, in which the period of incubation was two and a half years, and Colin has recorded a case in which it was said to have been nearly five years. The wound is usually healed long before any manifestations of hydrophobia occur, and the invasion of the latter is often unattended by local symptoms, though occasionally shooting pains and twitchings are felt at the seat of original injury. The development of hydrophobia is usually preceded for some days by a feeling of general *malaise*, together with chills, flushes, and giddiness. The most characteristic special symptoms of the disease, and those which Mr. Forster considers in themselves sufficient for diagnostic purposes, are intense pain and cutaneous sensibility, and spasms of the pharyngeal muscles, rendering it almost impossible to swallow anything, but especially liquids. To these there is usually added a feeling of great anxiety and a sense of impending danger, together with delusions alternating with the wildest delirium. There may be general convulsions, while there are almost always spasmodic movements of the mouth and of the laryngeal muscles, with expectoration of viscid and very tenacious mucus and saliva; hence the popular notion that the patient barks and tries to bite. Hydrophobia has, until recently, been thought an invariably fatal affection, but instances of recovery under the hypodermic use of woorara have been lately recorded by Offenburg, Polli, and B. A. Watson. Death may occur in one day, or life may be prolonged for nearly a week. As a *preventive* measure, excision of the part bitten is usually recommended. Mr. Youatt had great confidence in cauterization with nitrate of silver, and I may add that I was told by a negro, who had been for many years chief "dog-catcher" in this city, that he himself had been bitten many times by dogs suspected of being mad, and had never suffered any unpleasant consequences, having always used this remedy. I am disposed, however, to question (with Mr. Forster) whether either of these plans is really productive of benefit; the immense majority of bites will not be followed by hydrophobia under any circumstances, and, on the other hand, hydrophobia has occurred even after free excision of the injured part. Duboué, of Pau, suggests the daily administration of large doses of bromide of potassium during the whole period of incubation. When the disease occurs, the patient must be kept quiet in a darkened room, and free from all avoidable sources of irritation; his strength must be supported by such concentrated food and stimulus as can be taken, or by nutritious enemata, while an ice-bag may be placed to the spine, as recommended by Dr. Todd and Mr. Erichsen, and the violence of the spasms relieved by the inhalation of ether, or nitrite of amyl (Forbes), or by the use of large doses of bromide of potassium. Bouisson speaks very favorably of the employment of a *hot-air bath.* Dr. Hammond recommends the persistent employment of a primary current of electricity, one pole being applied to the head, and the other to the feet. Skinkwin, of Cork, advises transfusion, and Culver, of Jersey City, following a hint of Majendie's, intravenous injections of saline solutions; bromide of potassium, administered in this manner, is recommended by Duboué; as already mentioned, several cures have been recently reported from the administration of woorara, and others are said to have been obtained by inhalations of oxygen and by the use of the monobromate of camphor, and of cannabis indica. The only post-mortem appearance visible to the naked eye, which can be considered as characteristic, is, according to Mr. Forster, dilatation of the pharynx; but in cases recorded by Clifford Allbutt, Hammond, Gowers, and Cheadle, there were found decided changes in the medulla, spinal cord, and other nerve centres, consisting in congestion, softening, localized effusions of blood and serum, and, in some parts, granular degeneration. Inflammatory changes in the brain have been observed by Benedikt, of Vienna, and Wassilief, of St. Petersburg.[1] Congestion of the nervous structures in the vicinity of the wound, and inflammatory changes in the salivary glands, have been noticed by Nepveu, as have hyperæmia and an accumulation of white corpuscles in the kidneys, by Coats, of Glasgow.

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[1] The changes noted in the brain and spinal cord in cases of hydrophobia, are, however, according to Middleton, of Glasgow, by no means characteristic of that disease, but may be met with in any cases in which there has been great cerebral excitement.

Dissection Wounds are less frequently productive of unpleasant consequences at the present day, when anatomical subjects are prepared with antiseptic agents, than formerly; it is indeed much oftener from making autopsies, especially in cases of erysipelas, puerperal peritonitis, etc., than from the dissection of ordinary subjects, that this form of poisoned wound is met with. Even in performing surgical operations, surgeons are occasionally exposed to this form of injury: witness the melancholy case of the late Mr. Collis, of Dublin, who died from the effects of a slight wound received in excising an upper jaw. A cut received in dissecting or in operating may act merely as any other wound, producing an inflammatory condition, which will of course be aggravated if the person be in a depressed state of health when the injury is inflicted. Under such circumstances, the wounded part will swell, becoming hot and painful, and the neighboring lymphatics will probably become involved, with enlargement of the axillary glands, and a condition of general febrile disturbance. The inflammation may end in resolution, or may run on to suppuration, pursuing very much the same course as a severe whitlow. In other cases there is a positive inoculation of septic material, followed by diffuse cellular inflammation, or by phlegmonous erysipelas, involving a considerable part of the body, and attended by extensive suppuration, and perhaps sloughing; the general symptoms are those of extreme depression, and the patient dies of pyæmia or septicæmia, or recovers after a long and tedious convalescence, with his health, perhaps, permanently impaired. The first symptom of this more serious form of the affection is usually a small vesicle, which appears at the seat of the injury, sometimes within twelve hours, but usually on the second or third day.

If a wound is received in dissecting, it is proper to tie a ligature around the part to encourage bleeding, and to wash the wound thoroughly with soap and water; after which suction should be practised, provided that there be no abrasion about the mouth. The benefit of cauterization in these cases is somewhat doubtful, but if it be thought proper to employ it, strong nitric acid or the acid nitrate of mercury will probably prove the best agent. If, in spite of these precautionary measures, the wound give further trouble, the treatment must vary according to the form which the symptoms assume. The simple inflammatory affection which was first described, should be treated on general principles, poultices or other soothing applications being made to the injured part, and laxatives and diaphoretics administered internally. In the more serious form, in which there is evidence of blood-poisoning, more active measures must be adopted: the vesicle and adjacent parts should be freely incised, and the wound washed with diluted tincture of iodine. Anodyne fomentations may be then applied, and the strength of the patient must be kept up by the free use of stimulants and food, with quinia, camphor, and ammonia. If abscesses form, they should be opened as soon as fluctuation is detected. The proportion of recoveries from this form of the affection is stated by Travers to be but one in seven: if the case terminate favorably, the patient should be sent as soon as possible to the country, to recruit his shattered health by change of air and scene.

CHAPTER VIII.

GUNSHOT WOUNDS.

It is not my intention, nor, indeed, would it be possible, within the limits of this chapter, to attempt a full description of gunshot injuries, and of their modes of treatment. American surgeons have had ample opportunities for the study of this class of injuries during the last twenty years—more ample, it is to be hoped, than will again be afforded for a very long period; still, injuries from firearms are often enough met with in civil practice to render it important for every surgeon to be familiar with their more prominent features and peculiarities, and to be prepared to perform any of the operations which their treatment especially demands.

Characters of Gunshot Wounds.—These vary according to the nature of the projectile by which the wound is inflicted, and the force with which it produces its effect. The *momentum* of a gunshot projectile is an important matter for the surgeon's consideration. This depends upon two factors—the mass or weight of the projectile, and the velocity which it possesses at the moment of striking the body; thus, if a cannon-ball and a musket-ball, moving with the same velocity, strike at the same moment, the cannon-ball, from its greater mass, will have a greater *momentum*, and will produce the greater injury. A charge of powder alone, without any ball, or the wadding of the gun, if the latter be fired at short range, may produce a serious or even fatal injury, the great velocity making up for the slight mass.

A charge of *small shot*, if the gun be discharged in close proximity to the person struck, may enter the body *en masse*, as it were, and produce a large, ragged wound; or if the hand be struck, as occasionally happens to sportsmen from the premature discharge of a fowling-piece, may absolutely blow off a portion of the member as effectually as would be done by a piece of shell or a round shot, fired at a greater distance. When small shot scatter before they strike, they produce slighter wounds, though even then a single shot may destroy the eye, or cause fatal hemorrhage by wounding a large artery or vein.

Bullet wounds have increased greatly in severity since the introduction of rifled muskets and of conoidal balls. The old round musket-ball, fired from a smooth bore, produced a comparatively slight wound; thus I have on several occasions seen patients who had what might be called "button-hole fractures" of the tibia, caused in this way: simply a round aperture in the front of the bone, the ball sometimes lodging, and sometimes going completely through the limb, but causing no splintering, and no great laceration of the soft tissues. The peculiar shape of the modern conoidal ball causes it to meet with much less resistance from the air, while the spiral rotatory motion which is imparted to it by the grooves of the modern rifled firearm enables it to retain much more of its initial velocity, and thus to strike with much greater momentum than the old form of musket-ball; moreover, from its centre of gravity not coinciding with its centre of figure, in its passage through the air it acquires a peculiar *dip*, causing it to strike obliquely, making a large wound, ploughing and tearing up the soft parts, and splintering the bones in all directions. Thus, it is not uncommon for a long bone, such as the tibia or humerus, when struck by a conoidal ball, to be splintered and split both upwards and downwards, to the epiphyseal lines, or even into the adjoining articulations.[1]

Round shot or *cannon-balls*, unless moving with very slight velocity, are apt to tear off an entire limb, or whatever part of the body they may happen to strike; even when almost spent, and rolling along the ground with no more apparent force than a ten-pin ball, they are capable of producing most frightful injuries, as it is said foolhardy soldiers have occasionally learnt to their cost, in attempting to stop such a spent ball with the foot. The reason is obvious: though the velocity is slight, the mass and, therefore, the momentum are very great. On account of the great elasticity of the skin, it will occasionally escape injury from the blows of spent shot, while the parts beneath, bones, muscles, vessels, and nerves, may be frightfully torn or completely pulpefied. Such are the injuries which used to be attributed to the effects of the *wind* of a ball, passing close to, but apparently not coming in contact with, the person wounded. These injuries are apt to be followed by gangrene, which often seems to be due to rupture of the main artery, at a point higher than the seat of apparent lesion.

Shell wounds are among the most fatal injuries met with in modern warfare. The explosion of a single shell may kill or mortally wound quite a number of persons; the injuries most analogous to these which are met with in civil life, are such as are produced by accidents in blasting and mining, portions of metal or stone, or splinters of wood, being hurled violently by the force of the explosion against the bystanders, and often inflicting most serious and even fatal lacerations.

Nature of Gunshot Wounds.—In whatever way inflicted, gunshot wounds partake of the nature of contused wounds, and are often, as we have seen, attended by great laceration, while in certain cases, especially in the slighter forms of shell wound, the soft parts may be split to some distance from the point of contact of the projectile, and in these cases a portion at least of the wound may be clean cut, and approach therefore to the nature of an incised wound. Whatever part is, however, directly touched by the ball, is almost invariably so contused as to be deprived of vitality, and hence it may be laid down as an axiom, which holds good in this part of the world at least, that every gunshot wound must of necessity be followed by more or less sloughing. Indeed it is often said that every portion of the track of a ball must slough, and that in the case, for instance, of a perforating flesh wound of the extremities, a tubular slough will be separated, representing exactly the course of the ball. I believe, however, that this rule is not invariable; in the early part of our late war, when buckshot were occasionally used in the form of "buck and ball cartridges," I saw several cases of very small perforating flesh wounds thus produced, in which, although undoubtedly both the apertures of entrance and of exit sloughed, the deep parts of the wound apparently healed without the occurrence of sloughing; and to suppose that such might be the case is not at all unreasonable, for the swelling of the tissues would measurably convert the deeper portion of the wound into a subcutaneous injury, placing it thus in a condition which, as we know, will allow of great laceration without inevitable loss of vitality. The sloughing of gunshot wounds is not due, as was formerly supposed, to any poisonous qualities of the projectile, nor to its temperature,[1] nor to any fancied development of electricity, but simply to the excessive degree of contusion inflicted by the ball, which, though usually of small mass, strikes with great momentum.

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[1] Prof. Middleton Michel, of Charleston, maintains that the splintering caused by the conoidal bullet is less than is commonly supposed, and that when fired at short range it produces comparatively little injury, its destructive effects being inversely proportionate to its velocity.

Wounds of Entrance and Exit.—Most gunshot wounds have two apertures, one where the ball came in[2] and the other where it went out. If there be but one wound, it is *primâ-facie* evidence that the ball has lodged and remains in the part; though more rarely a spent ball may drop out by the same opening as that by which it entered, or striking some prominent part, as the larynx or a rib, may be deflected from its course, and, restrained by the elasticity of the skin, may make a complete circuit around the chest or neck, as the case may be, coming out at last at the same point at which it went in. Well-attested illustrations of these statements may be found in works on military surgery. On the other hand, the existence of two wounds is not positive evidence that there is no ball in the part; for a ball may split on a ridge of bone or other projecting object, one portion passing out and making an aperture of exit, while the other lodges; or, which comes to the same thing, two balls may enter at one opening, one passing out and the other remaining. Again, there may be more than two wounds. I had under my care, after the battle of Antietam, a Confederate soldier who had three wounds in the fleshy part of the thigh; they were all in a line, superficial flesh wounds, almost identical in appearance, and with nearly equal intervals between them. Either two balls had entered together, and, separating in the tissues, had come out by different apertures, or, which from the position of the wounds seemed more probable, two balls had entered by distinct openings, and, meeting in the limb, had come out together. Not unfrequently a ball perforates both lower extremities, thus making four wounds, and I have even seen five wounds, evidently made by the same ball. Thus, I remember a soldier who had apparently been struck by a ball passing obliquely upwards, while his arm was flexed at the elbow and somewhat elevated; the ball had grazed the forearm, perforated the upper arm (just missing the brachial artery), and then entered the chest, superficially wounding the lungs, and ultimately emerging below the scapula.

The apertures of entrance and exit present somewhat different appearances; these were better marked when round balls were in common use than at the present time, when gunshot wounds are usually inflicted by conoidal bullets. The entrance wound is usually smaller than that of exit, and, indeed, from the elasticity of the skin, often appears smaller than the ball which made it; its edges are rather inverted than everted, and, if the weapon has been discharged at a very short distance, the skin may be blackened by the explosion of the powder. The exit wound has everted edges, is ragged and more irregular than that of entrance, and is usually larger. These differences are owing to several circumstances, among which may be enumerated the reduced velocity of the projectile at the moment of exit, the diminished degree of resistance offered by the soft parts, which at the point of exit are unsupported, and therefore more liable to laceration, and the actual increase in bulk of the projectile from carrying portions of tissue before it—a similar explanation to that given by Mr. Teevan for the larger size of the exit than of the entrance wound in cases of punctured fracture of the skull.

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[1] Hagenbach, Socin, and Busch, however, have lately adduced experimental proofs to show that balls in passing through the tissues of the body undergo an actual increase of temperature sufficient to cause partial melting of the projectiles.

[2] Dr. Skae has reported a case in which a lunatic shot himself with a pistol ball *through the ear*, thus producing a fatal injury without any wound which could be recognized during life; and a curious case occurred during our late war, in which an officer was mortally wounded *through the anus*.

The statement above given may be considered as generally, though not invariably, correct; thus, it is easy to understand how a conoidal ball, striking with its long axis corresponding to the surface, might make a large and ragged wound, and, undergoing partial rotation from the resistance of the tissues, might emerge point forwards, thus making the exit wound smaller and more regular than that of entrance. Again, the distinctive appearances of the apertures may be obliterated, or their characters reversed, by the processes of sloughing and suppuration. There is most sloughing at the point of entrance, for here the momentum of the projectile was greatest, and hence, in the subsequent stages of a gunshot wound, the aperture of exit may be absolutely smaller than that by which the ball entered.

Direction of Ball.—The direction taken by a ball in traversing a part is usually in a straight line from aperture to aperture. To this rule there are, as already stated, exceptions, from deflection of the ball by means of a ridge of bone, tendon, fascia, etc. Still, the rule holds good in the immense majority of cases, and the surgeon may often derive valuable information by bearing it in mind; thus, it has happened that in cases of secondary hemorrhage it has been impossible to discover the source of bleeding, till by placing the patient in the exact position which he occupied when shot, and looking along the line which the ball must have taken, it has become obvious that a certain vessel was in the way of being wounded, and the proper point for the application of a ligature has been thus made at once evident. A familiar instance of the value in another respect of this mode of examination, is that which occurred to Sir Astley Cooper, who, by resorting to this plan in a case of murder, determined that the fatal shot could only have been fired by the *left hand*, a point of circumstantial evidence which eventually led to the detection and conviction of the criminal.

Symptoms of Gunshot Wounds.—The symptoms of gunshot wounds vary with the part affected, the nature of the missile, and other circumstances. The amount of *shock* is, according to Drs. Mitchell, Morehouse, and Keen, apt to be greater in wounds about the upper third of the body than in other parts. The attitude assumed by the person shot, immediately on receipt of the wound, varies with the locality of the latter; a man shot in the head usually falls forwards, while one shot about the shoulder often involuntarily turns round, making a half revolution, or a complete or even two revolutions, before falling. The first stage of shock may be very evanescent, the patient when first seen being in a state of wild excitement, delirious, or even maniacal; this is said to be particularly noticeable in wounds about the genital organs. The behavior of men when shot in battle is influenced by a variety of circumstances; thus, marked differences have been observed in accordance with the race of the person wounded. The Anglo-Saxon is usually calm and philosophical; the Celt sometimes gay and merry, and at other times depressed and gloomy; the Teuton phlegmatic. The negro soldiers during our late war were, according to the testimony of Dr. Brinton and other army surgeons, the most patient and enduring of all our wounded; another peculiarity was that, while the white troops of all races almost invariably threw away their muskets when shot, the negro soldier as regularly brought his into hospital with him, and was not satisfied to have it taken from his sight.

The *pain* of gunshot wounds is sometimes very slight; indeed, in the heat of action, a soldier is often unaware that he is wounded, till he feels the trickling of blood, or sees its stain upon his clothes. When the shot is felt, the sensation is variously described as that of a blow from a cane or sharp stone, as a burning rather than a pain, or as an electric shock. In some cases, when nerve trunks are involved, there is most distressing pain referred to other and occasionally far different parts of the body; in other cases a still more curious phenomena is observed, viz., local temporary paralysis of motion and sensation, caused by concussion or commotion of a large nerve, from a ball passing near without directly injuring it.

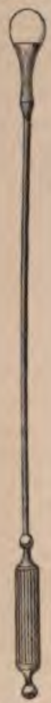
Primary hemorrhage, contrary to what might be supposed, is not a prominent symptom of gunshot wounds, but, when it does occur to any great extent, usually proves almost instantly fatal. Even when a limb is carried off by a shell or round shot, the peculiar way in which the vessels are torn asunder allows contraction and retraction to occur, and there is much less bleeding than would be anticipated. In ball wounds of the extremities, the natural elasticity and resiliency of the vessels seem to enable them to elude the projectile, and we often find the track of a wound apparently crossing directly the line of a main artery which yet has entirely escaped injury. In other cases, as in wounds of the lung, there is a sudden gush of blood, which induces fainting, and before the patient recovers consciousness, a clot forms, and the bleeding may not be renewed. Hence, death from hemorrhage on the battle-field is a rarer occurrence than is generally supposed; the cases which do prove fatal in this way, are usually those of wound of the heart itself, or of one of the large internal arteries, such as the aorta or pulmonary artery, or of wound at the root of the neck, where arterial retraction and contraction cannot occur, and where the condition may be additionally complicated by the entrance of air into the great veins in that situation.

The *secondary symptoms* of gunshot wounds do not materially differ from those of other lacerated and contused wounds of the same severity. There is always a good deal of inflammation, with perhaps more swelling than in ordinary contused wounds, attended by constitutional disturbance, fever, and perhaps traumatic delirium. The slough begins to separate about the sixth day; and, when it has entirely come away, the extent of destruction is often found to be much greater than was at first supposed. During the whole period of separation of the slough, there is great risk of *secondary hemorrhage;* this usually takes place from the tenth to the fifteenth day, though it may occur as early as the fifth or as late as the thirtieth. Secondary hemorrhage may, of course, be caused at a still later period by some accidental circumstance, such as the puncture of a large artery by a spicula of necrosed bone, as in a case recorded by Dr. Chisolm, in which bleeding occurred on the 328th day, or in the still more remarkable case recorded by Dr. William Hunt, in which fatal secondary hemorrhage similarly occurred nearly three years after receipt of the injury, which was not, however, in this instance, a gunshot wound. *Erysipelas*, *pyæmia*, *hospital gangrene*, and *tetanus*, may each prove a cause of death after gunshot injury, but do not, under such circumstances, present any different phenomena from those which they exhibit when occurring after the lesions met with in civil life.

Treatment of Gunshot Wounds.—All gunshot injuries may be divided, as regards the question of treatment, into those which do, and those which do not, require amputation or excision. The latter division is by far the more numerous, embracing most of those which are known as flesh wounds, together with all of the more serious class of penetrating wounds of the great cavities of the body. Thus, there were registered at the office of the Surgeon-General U. S. A., up to Sept. 30, 1865, only 8825 gunshot fractures of the extremities, as compared with 46,400 simple flesh wounds of the same parts. The immediate indications for treatment, in a case of gunshot wound in which the question of operative interference does not arise, are three in number, viz., (1) to promote reaction, (2) to arrest hemorrhage, and (3) to remove all foreign bodies. The first point has already been sufficiently considered in previous chapters, and need not be again referred to.

Hemorrhage.—With regard to the *arrest of hemorrhage*, from what was said above it will be seen that there are comparatively few cases in which the surgeon has the opportunity to treat primary bleeding. Of over 17,000 operations tabulated in Circular No. 6, S. G. O., 1865, there were but 404 ligations of arteries, and most of these were for secondary, not primary, hemorrhage. Still, cases are occasionally met with in which patients die from avoidable bleeding on the field of battle, as is said to have happened in the case of a distinguished officer in the Confederate service, who bled to death from a wound of the posterior tibial artery, and whose life might not improbably have been saved by prompt ligation of the wounded vessel. For temporary control of the bleeding artery the surgeon may use the ordinary tourniquet, or may improvise one in the form of the common Spanish windlass (Fig. 25), twisting the knot with a drum-stick or the handle of a sword. It has been recommended to distribute field tourniquets to soldiers on the eve of a battle, with instructions for their use; but it is the general opinion of military surgeons, that the cases of serious primary hemorrhage are really so rare, and the risk of producing injurious venous congestion by the improper use of the tourniquet so great, as to render the distribution of these instruments among troops more apt to be productive of harm than of benefit.

FIG. 76.

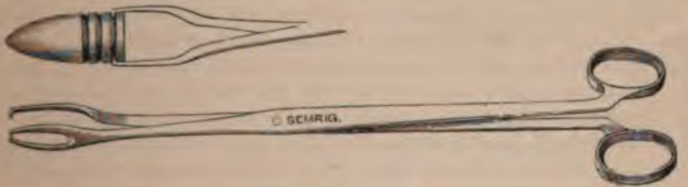


Nélaton's probe.

Suppose a surgeon to find a man who has evidently lost a great deal of blood, with a deep wound filled by a recent clot which has for the moment checked the hemorrhage, what course should be pursued? If the wound were in a situation in which it would be difficult or even impossible to apply a ligature, as in the chest or abdomen, there can be no question that the proper course would be to allow the clot to remain, in hope that under its protection the wounded vessel would close by the natural processes which will be considered hereafter; and even if the wound were in one of the extremities, it would probably be right to wait until full reaction had occurred before running the risk of provoking fresh bleeding by handling the wound. If, on the other hand, the wounded vessel were in an easily accessible situation, and the patient not much exhausted, it would be better to remove the clot as any other foreign body, and apply the proper treatment directly to the wounded artery.

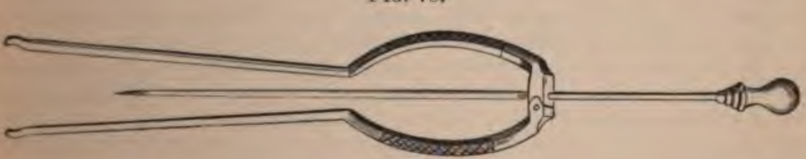
Removal of Foreign Bodies.—Bleeding having ceased, and the patient having reacted sufficiently to bear examination of the wound, the surgeon should proceed to remove all foreign bodies, the ball, if it have not passed out, and any portion of wadding, clothing, etc., that may have entered the wound. The finger constitutes the best probe for all parts within its reach, but for exploration of the deeper portions of the wound, various bullet-probes may be employed. *Nélaton's probe* differs from the ordinary form of the instrument, in being capped with unglazed porcelain, which, by receiving a metallic streak, surely indicates the presence of a leaden ball, if the latter come in contact with it.[1] It was by means of this probe that the eminent French surgeon, whose name it bears, was enabled to demonstrate the presence of a ball in the wound of the celebrated Italian General, Garibaldi. Longmore speaks favorably of Lecompte's "*stylet-pince,*" or "*probe-nippers,*" by which the surgeon can withdraw a minute portion of the foreign body for examination. Culbertson, of Ohio, has devised a *meerschaum probe* which serves the purpose of Nélaton's instrument, and is besides provided with a roughened surface to catch and withdraw filaments of clothing, etc., which may be in the wound. *Electric probes,* containing two insulated wires, have been devised by Favre, of Marseilles, and others, for the detection of balls, the effect of the metallic contact being to complete the circuit, and thus indicate the nature of the foreign body. Dr. Bill has invented an ingenious *magnetic probe,* employing the audient of a telephone as an indicator. An older instrument is the *drum* or *reverberating probe* of L'Estrange, an Irish surgeon, which is provided with a small sounding-board to indicate to the ear the nature of the body struck. Deneux suggests the use of a probe carrying a mass of charpie dipped in dilute *acetic acid;* by contact with the ball the acetate of lead is formed, and the presence of the metal may then be demonstrated by means of suitable reagents. Uhler, of Maryland, injects *dilute acetic* or *dilute nitric acid,* and then tests the injected fluid for lead and iron respectively.[2] If the course of the ball be very circuitous, advantage may be derived from the use of *flexible probes,* such as those of Sayre, Steel, Sarazin, and other surgeons. For the *extraction* of balls, forceps of various kinds may be employed, or if the ball be imbedded in bone, it may sometimes be removed by the *tirefond,* or screw extractor (Fig. 78); while if superficial, it may often be readily turned out with a scoop, or with the extremity of an ordinary grooved director. In other

FIG. 77.



Bullet-forceps.

FIG. 78.



Screw Extractor.

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[1] Dr. Highaway, of Cincinnati, is said to have employed for this purpose, during the Mexican war, the stem of a clay tobacco pipe.

[2] The same surgeon suggests that the presence of a splinter of wood might be recognized by detecting *tannic acid* in the discharges.

cases, again, a ball is most conveniently reached by means of a counter-opening. Beside the information afforded by the finger or probe as to the presence and position of foreign bodies, the surgeon can thus obtain valuable knowledge as to the condition of the wound itself, and, in case the bone have been injured, as to the extent of its comminution. The splinters of bone produced by gunshot injuries were classified by Dupuytren into primary, secondary, and tertiary splinters or sequestra. The *primary* are such as are entirely detached, and should be immediately extracted, as they will otherwise produce irritation, acting as foreign bodies; the *secondary* sequestra are partially detached, and if very loose should be removed, but if pretty firm may be pushed back into place; the *tertiary* should always be preserved, as their vitality is not much impaired, and they serve a most useful purpose in assisting recovery by strengthening the new-formed callus.

Dressing.—The wound being freed from all foreign bodies, loose splinters, etc., the surgeon proceeds to *dress* it. It was formerly the almost universal custom to enlarge gunshot wounds with the knife, and this practice, under the name of *débridement*, is still pursued by many European surgeons. It is doubtless useful in some cases, when there is much swelling, especially in the suppurative stage, to make more or less free incisions to relieve excessive tension, just as would be done in the case of any other wound, in which the original opening did not give sufficient vent; but in the immense majority of cases of gunshot injury this treatment is not at all necessary.

Gunshot wounds are to be treated on the ordinary principles which guide the surgeon in the management of other injuries, and require no special or exclusive dressing. Cold water was most extensively employed during our late war, and as a primary application answers very well; if too long continued, however, it produces a depressing influence on the part, the granulations becoming pale and flabby, and showing an indisposition to heal. In civil practice I have found the best primary dressing to be laudanum, pure or diluted, as with other contused and lacerated wounds; changing it for poultices or warm fomentations when the sloughs begin to separate, and again using more stimulating dressings, such as lime-water, etc., when the process of granulation is fairly established. During the period of separation of the sloughs, if, from the position of the wound, there is reason to fear the occurrence of secondary hemorrhage, it is well to apply a tourniquet loosely around the limb above the seat of injury, and to instruct an attendant in its use, that it may be screwed up on the first onset of bleeding. By the employment of this *provisional tourniquet*, as it is called, many lives may be saved that would otherwise inevitably be lost.

Amputation and Excision in Gunshot Injuries.—*Amputation* may be rendered necessary in cases of gunshot injury by various circumstances; thus, if part of a limb be entirely carried away by a round shot, or by a fragment of a shell, there is nothing for the surgeon to do but to improve the form of the stump thus made, and endeavor to promote its healing. Many cases of gunshot fracture require amputation, either from extent of lesion of the bone itself, or from the concomitant injury to the soft parts. Especially do wounds of the main arteries and nerves of a limb, in conjunction with fracture, demand amputation. Even if the bone itself be not injured, it may be so extensively denuded that removal of the limb becomes the surgeon's only recourse. When it is evident that, from the severity of the injury, amputation will be required, it should, in accordance with the principles enunciated in Chapter V., be performed as soon as possible after the occurrence of reaction. It may, however, even in cases which at first promise well, be required, as will be seen hereafter, as a secondary operation, on account of the occurrence of hemorrhage, of acute suppurative osteo-myelitis, or of extensive necrosis.

The introduction of *Excision of Bones and Joints* as a substitute for amputation in military practice, is comparatively an affair of modern times; the operation has, however, been so successful, at least in the upper extremity, that it may now be said that in most cases of injury of this part of the body, excision should be the surgeon's first thought, and should be preferred to amputation whenever the destruction of parts does not manifestly render the latter operation imperative.

Shoulder.—Gunshot fractures involving the shoulder-joint very often require excision, the operation having, apparently, been first employed by Percy in 1792. The statistics of the operation during our late war, as recorded by Dr. Otis, give a total of 1086 cases. The results are known in all but 135. The mortality was 31 per cent. for primary, 46 per cent. for intermediate, and 29.3 per cent. for secondary cases. This proportion is less favorable than that of shoulder-joint amputation, of which the mortality during our war was, according to the same authority, 29.1 per cent. Expectant treatment (reserved of course for selected cases) gave a death-rate of only 27.5 per cent. Gurlt's tables embrace 1661 cases of excision, with 567 deaths, a mortality of 34.7 per cent. In spite of its slightly greater fatality, excision should, I think, be preferred to amputation in any case admitting of a choice between the two operations. Even if the humerus be split for a considerable distance downwards through its shaft, excision may still be practised, not a few instances having occurred during our war, in which very large portions of the humerus were removed by excision, a useful hand and forearm being thus preserved.

Elbow.—Excision of the elbow, introduced into military practice by Percy, was frequently performed during our war,[1] 764 cases being noted in Dr. Otis's *Surgical History*. In 716 of these cases, in which the results are known, there were 165 deaths, a mortality of 23 per cent. The death-rate, according to these figures, would appear to be slightly less than that of amputation of the lower third of the arm, 25.9 per cent., and hence excision should be preferred in all suitable cases. The secondary were more successful than the primary excisions, while the intermediate operations were much the most fatal. According to Dominik, secondary excisions are also the most favorable as regards the utility of the limb. The same writer considers partial more successful than total excision of the elbow, and his view is adopted by Hueter, Langenbeck, and Gurlt; but the experience of our war, as given by Dr. Otis, is decidedly in favor of the more sweeping operation. Gurlt's tables give 1438 cases of elbow excision with 349 deaths, a mortality of 24.87 per cent.

Wrist.—Excision of the wrist-joint has not been much practised in military surgery; the results of such operations as are recorded have been sufficiently satisfactory as regards life, but rather unsatisfactory as regards the utility of the preserved limb. Dr. Otis records 90 cases, of which 15, or 16.67 per cent. terminated fatally. Gurlt gives 133 cases with only 20 deaths.

Hip.—Gunshot injuries of the hip-joint are universally regarded as among the gravest injuries met with in military practice. The comparative advantages of excision,[2] amputation, and expectant treatment in these cases, have been fully and ably investigated by Dr. Otis, U. S. A., in Circular No. 2, S. G. O., 1869, and the statistics which bear upon the question are exhibited in the following tables:

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[1] The first case in American military surgery is attributed to Dr. Otis Hoyt, during the Mexican war (1847).

[2] First adopted in military practice by Oppenheim, in 1829.

Excisions.	Cases.	Died.	Recovered.	Death-rate.
Primary,	39	36	3	92.3
Intermediate,	33	30	3	90.9
Secondary,	13	11	2	84.6
Aggregate,	85[1]	77	8	90.6

Amputations.	Cases.	Died.	Recovered.	Doubtful.	Death-rate.
Primary,	79	75	1	3	98.68
Intermediate,	76	70	6	...	92.10
Secondary,	20	13	7	...	65.00
Re-amputations,	8	4	4	...	50.00
Aggregate,	183	162	18	3	90.00[2]

Gurlt's statistics show very much the same mortality, 139 cases having given 122 deaths, or 88.40 per cent.

The mortality in cases treated during our war by expectancy was 93 per cent., or, including cases in which the acetabulum was involved, 96 per cent. During the late Franco-Prussian war, as reported by Richter, 33 cases of wound of the hip, treated by expectancy, furnished 31 deaths, and 21 treated by excision 18 deaths, while 11 hip-joint amputations all terminated fatally.

From these facts the conclusion is fairly drawn that, in any case of gunshot injury of the hip-joint, primary excision should be preferred to any other mode of treatment, and this simply to increase the chance of life, without reference to the utility of the preserved limb. Of course there may be such extensive destruction of parts as to put excision out of the question, and in such cases the surgeon must still have recourse to what Hennen called the "tremendous alternative" of hip-joint amputation, an operation which may also be required secondarily, after an unsuccessful attempt to save the limb. The accompanying illustration (Fig. 79), from a photograph, shows the condition of the bone in a case in which I performed (unsuccessfully) secondary amputation at the hip-joint, for gunshot fracture of the head and neck of the femur. The specimen is now in the museum of the Episcopal Hospital.

Knee.—"Wounds of the knee-joint," says Guthrie, "from musket-balls, with fracture of the bones composing it, require immediate amputation." Unfortunately, this rule still holds good. The statistics of excision of the knee-joint, for gunshot injury (first performed by Fahle, in 1851), have been particularly investigated by Cousin, Chenu, Lotzbeck, Küster, Culbertson, and Gurlt. Cousin finds that 33 cases of total excision have given 5 recoveries and 28 deaths (85 per cent.), while 11 cases of partial excision have given but one recovery and 10 deaths (91 per cent.). Of the whole 44 cases,

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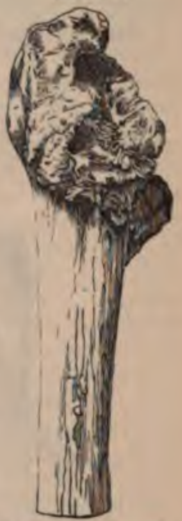
[1] One (fatal) case should be omitted, as not strictly an excision, which would lessen the death-rate.

[2] Doubtful cases omitted in computing percentages.

38 proved fatal, a mortality of over 86 per cent. Chenu's figures, derived from the records of the Franco-Prussian war, show a still larger death-rate, 37 complete excisions having given 33 deaths (89 per cent.), and 65 partial excisions 62 deaths (95 per cent.), or the whole 102 cases 95 deaths, a mortality of over 93 per cent. Lotzbeck's and Küster's statistics, though somewhat more favorable, are still sufficiently gloomy, 66 cases collected by the former writer giving 48 deaths (nearly 73 per cent.), and 101 cases collected by the latter giving 66 deaths, a mortality of over 65 per cent. Culbertson gives 44 complete excisions with 33 deaths, and 16 partial excisions with 12 deaths, a mortality for either category of 75 per cent., while Gurlt's tables give 146 cases with 111 deaths, a mortality of 77.08 per cent. When we compare the above figures with the death-rate of amputation in the lower third of the thigh (55 per cent. according to Legouest, 50 per cent. according to Macleod), the conclusion is surely irresistible that excision of this joint should be banished from the practice of military surgery, and that the rule should still be regarded as imperative, that every gunshot fracture of the knee-joint is a case for amputation.

Ankle.—Fifty cases of complete excision of the ankle (first employed in military practice by Langenbeck, in 1859), are reported by Grossheim as having occurred during the late Franco-Prussian war; of these, 26 terminated in recovery, and 20 in death, the result in 4 cases not having been ascertained; partial excisions (including operations upon the tarsal bones) were more successful, 47 cases having given 33 recoveries and only 14 deaths. Gurlt's figures embrace 150 cases with 51 deaths, a mortality of 34 per cent.

FIG. 79.



Gunshot fracture of hip.

Gunshot Fractures of Shafts of Long Bones very commonly require amputation. The preservation of a limb which is the seat of such an injury can less often be effected now than formerly, on account of the great severity of the bone lesions produced by the use of the conoidal bullet and of the modern improved forms of firearm. The results of excision in such cases, during our war, are shown in the following table taken from Circular No. 6, S. G. O., 1865, and the second volume of Dr. Otis's *Surgical History:*

Excisions in continuity.	Died.	Recovered.	Undetermined.	Total.	Mortality, per cent.
Humerus, ...	191	477[1]	28	696	28.5
Bones of forearm, . .	109	856	21	986	11.2
Metacarpal bones, . .	10	104	2	116	9.6
Femur, ...	32	6	24	62	84.2
Bones of leg, ...	27	112	37	185[2]	19.4
Metatarsal bones, . . .	5	26	2	33	16.1

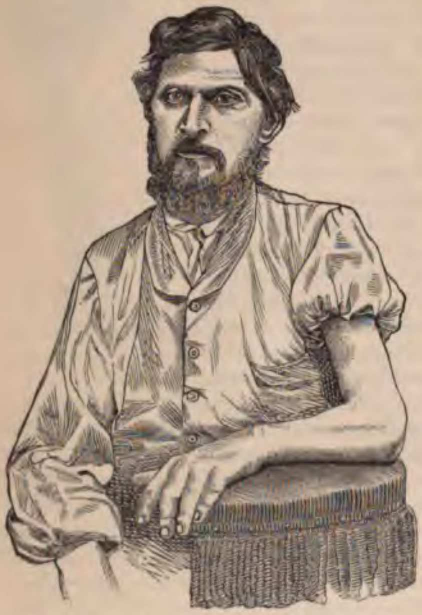
Comparing these figures, when the number of cases is sufficiently large to justify their being used for statistical purposes, with the results of amputations of the same parts, as given in previous chapters, we may conclude that—(1) excision in the continuity of the bones of the forearm is permissible in favorable cases; (2) excision in the continuity of the humerus is more fatal than amputation of the corresponding parts, and is so often followed by non-union as to be in most cases an undesirable operation; (3) excision in

[1] In 164 cases bony union did not occur.
[2] Subsequent amputation in nine cases.

the continuity of the femur is a bad operation, and should be definitively rejected from military practice; (4) excision in the continuity of the bones of the leg is less fatal than amputation, and might, therefore, be resorted to in selected cases, though the number of undetermined results at the date of issue of Circular No. 6 was still so large that this conclusion may very probably be ultimately reversed; (5) excision in the hand or foot is not an operation to be recommended.

Judging from my individual experience, which is, of course, limited, I should say that except in the case of the radius or ulna separately, and perhaps of the fibula, excision in the continuity of the long bones was an undesirable operation. Those cases of resection of the shaft of the humerus or tibia, which I have observed, have either required subsequent amputation, or have preserved limbs of very questionable utility: the case is very different from one of necrosis or ununited fracture, and, I believe, there is as yet no instance on record, of useful reproduction of bone, in a case of excision in continuity, for gunshot or other traumatic injury.

Fig. 80.



Result of partial excision of radius for gunshot injury. (From a patient in the Episcopal Hospital.)

In the case of the separate bones of the forearm, however, most excellent results may be obtained by excision. I have myself twice excised considerable portions of the radius, in cases of gunshot fracture, one being a primary (Fig. 80), and the other a secondary operation; both patients made good recoveries.

Of 7888 completed cases of gunshot fracture of the humerus, recorded in Dr. Otis's *Surgical History of the War*, amputation or excision was practised in 4928, and conservative treatment was adopted in 2960, with a ratio of mortality of 24.1 per cent. in the former, and 15.2 per cent. in the latter category. These statistics show that in the upper extremity, at least, gunshot fracture may very often, though in a numerical minority of cases, be recovered from without operation. In the lower extremity, the case in somewhat different. The mortality of gunshot fracture of the upper third of the thigh is, indeed, less when treated by expectancy than after amputation, which, in this situation, is an extremely fatal operation; in the middle of the thigh the mortality is about the same under either mode of treatment; but in the lower third, or in gunshot injury of the knee-joint, amputation gives much the best results. These points will appear from the following table, condensed from one in Circular No. 6:

Statistics of Gunshot Fractures.	Mortality per cent.	
	Amputation.	Expectation.
Upper third of femur,	75.00	71.81
Middle " " "	54.83	55.46
Lower " " "	46.09	57.79
Wound of knee-joint, with or without fracture,	73.23	83.76

In gunshot fracture of the leg, if the splintering of the bones be not very great, and if the vessels and nerves have escaped injury, an attempt may be made to preserve the limb, the mortality, according to Circular No. 6, being but 24 per cent. under all modes of treatment.

Remote Consequences of Gunshot Injury.—There are certain indirect or remote consequences of gunshot wounds which may demand the attention of the surgeon. These are principally manifested in the bones, the vessels, and the nerves.

Bones.—The vitality of a bone may be seriously impaired by a gunshot wound, which, at first, is supposed to have inflicted no injury upon it. The subjects of contusion and of contused wounds of bone, have been ably investigated by Dr. John A. Lidell, formerly surgeon in the U. S. Volunteer Corps, who has published his views in an elaborate paper in the *American Journal of the Medical Sciences* for July, 1865. Dr. Lidell has traced seven distinct conditions, which may result from contusion of bone, and each of which is fraught with more or less danger to the patient; these are: 1. Ecchymosis of the osseous tissue; 2. Ecchymosis of the medullary tissue; 3. Simple osteo-myelitis (attended with production of new bone, both from the periosteum and from the medulla); 4. Necrotic osteitis, or an inflammation of bone so severe in character as to terminate in necrosis; 5. Suppurative osteomyelitis; 6. Gangrenous or septic osteo-myelitis (both this and the last-named condition are almost certain to terminate fatally); and 7. Necrosis produced directly by the contusion of bone, without the intervention of either ecchymosis or inflammatory irritation.

If the bone which is contused be in the neighborhood of an articulation, the latter may undergo serious or fatal disorganization; or if an important organ, as the brain, be adjacent, secondary visceral disease may ensue.

Vessels.—Traumatic aneurism of the circumscribed variety, occasionally, though rarely, follows a gunshot injury; the diffused traumatic aneurism is a more frequent result of these wounds, and constitutes a most serious affection. I have seen one case of arterio-venous wound, resulting in aneurismal varix, produced by a musket-ball passing directly between the femoral artery and vein.

Nerves.—Very curious nervous affections are occasionally observed as consequences of gunshot wounds. These affections may consist of paralysis of either motion or sensation, or both, of hyperæsthesia, of choreic movements, etc. This subject has been particularly investigated by Drs. Mitchell, Morehouse, and Keen, of this city, whose labors in this department will be again referred to in a subsequent chapter.[1]

Encysted Balls.—Balls sometimes become encysted, that is, surrounded by a layer of dense cellular tissue, within which they may remain without producing any irritation, for a very long period. There are well-attested cases on record in which encysted balls have remained harmlessly in the tissues for forty or even fifty years; in other cases, again, after a variable interval, they excite inflammation by acting as foreign bodies, and may produce serious or even fatal consequences. Especially when lodged in the lung or pleural cavity is this apt to be the case, so that it is given as a rule by many authorities, that any gunshot wound of the thoracic cavity, in which the ball remains lodged, will sooner or later cause death.

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[1] See also remarkable cases reported by Dr. J. H. Brinton (*Am. Journ. of Med. Sciences*, Oct., 1870, p. 435), and by Dr. B. Rhett (*Ibid.*, Jan., 1873, p. 90).

CHAPTER IX.

INJURIES OF BLOODVESSELS.

INJURIES OF VEINS.

Subcutaneous Rupture of Veins occasionally occurs as a consequence of external violence, and is manifested by the extravasation of a large quantity of blood, which is, however, usually absorbed again in the course of a few days; or the blood may coagulate, the clot subsequently exciting suppuration, or possibly becoming organized, as pointed out in Chapter VII. More rarely, the blood may become encysted in a fluid state, constituting what is sometimes called a venous aneurism.

Open Wounds of Veins are not unfrequently met with in civil practice, and occasionally give rise to most serious consequences.

Hemorrhage from a Wounded Vein is marked by the even and rapid flow, and the dark[1] color of the effused blood. In certain situations, as at the root of the neck, or under peculiar circumstances, as when veins are affected by varicose disease, the hemorrhage may be so profuse as to endanger life. Wounds of the internal jugular vein are indeed extremely fatal accidents, eighty-five cases collected by Dr. S. W. Gross having been followed by death in no less than thirty-seven instances. Hemorrhage from superficial veins can usually be readily controlled by pressure, or even by position. Thus the most profuse bleeding, from rupture of a vein in a varicose ulcer of the leg, may often be checked, simply by elevating the limb. The large superficial veins on the back of the hand are often wounded by accidents from broken glass; in such cases I have found it a good plan to transfix both ends of the bleeding vessel with a metallic suture, thus arresting the hemorrhage and closing the wound at one and the same time. In any case in which pressure cannot conveniently be applied, the surgeon should not hesitate to use a ligature. There was formerly a great prejudice against the practice of tying veins, from the supposition that it was liable to induce pyæmia, but now that modern researches have shown that there is no necessary connection between that process and inflammation of the veins, or phlebitis, the theoretical grounds for opposition are removed, and it is established by clinical observation that the risks of tying veins are much less than was formerly believed. The *lateral* ligature, which was first practised by Mr. Travers in a case of wound of the femoral vein, consists in pinching up the bleeding orifice, and throwing around it a delicate ligature, so as not to obliterate the calibre of the vessel; this plan, which has theoretical merits, is found in practice to be very apt to be followed by secondary hemorrhage, so that it is now generally abandoned, the vein being tied as an artery, above and below the bleeding point. The process by which nature arrests bleeding from a vein is essentially that which will be presently described in speaking of wounded arteries, a clot forming in the vessel, and the cut edges subsequently uniting through the development of local inflammatory changes. After ligation, which corrugates but does not divide the coats of the veins, a clot forms on the distal side of the ligature, which gradually cuts its way through, as in the case of an artery, though in a shorter time in proportion to the size of the vessel.

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[1] Dr. H. A. Potter, of Geneva, N. Y., has observed in eight cases of spinal injury, that the blood drawn from a vein is of arterial hue; this observation has, however, not been confirmed by others.

Phlebitis may follow a wound of a vein, and was formerly supposed to be the cause of pyæmia, which occasionally occurs and proves fatal after such an injury: this subject will be fully discussed in another part of the volume.

Entrance of Air into Veins.—The most frightful and fatal consequence of venous wounds, though fortunately one which is rare, is the entrance of atmospheric air, and its transfer to the heart. This accident is principally met with in cases of wound of the internal jugular, or of the other large veins situated at the root of the neck, or in the axilla, and this part of the body is accordingly often spoken of by surgeons as the "dangerous region." It has, however, occurred in other parts of the body; thus, in a case of the late Prof. Mott's, serious though not fatal symptoms followed the entrance of air into the facial vein where it crosses the lower jaw, while this accident occurring in the femoral vein is supposed to have been the cause of death in a case of thigh amputation during the Crimean war.[1] The mode in which air is pumped into the veins is easily understood: during the act of inspiration, a vacuum is created in the thorax, to supply which air rushes through the trachea or through any other opening into the interior of the chest; thus, in the case of wounds of the pleura, air is sucked in during inspiration, to such an extent as often to induce collapse of the lung and pneumothorax, and in the same way, if a large vein in the neighborhood of the thorax be wounded, and be prevented from collapsing by the natural connections of the part, by the position of the patient, or by a structural change in the vessel itself (to which the French give the name of *canalization*), the act of inspiration will mechanically and necessarily pump air into the open vein, precisely as it does through any other aperture into the chest. The *local signs* of entrance of air into a vein, consist in a peculiar sound, variously described as of a *hissing*, *gurgling*, *sucking*, or *lapping* character, and in the appearance of frothy bubbles in the wound. The *constitutional symptoms* are equally well marked. The patient cries out, impressed with a sense of certain and rapidly impending death, and falls almost instantly into a semicollapsed state, moaning and perhaps struggling; the pulse is almost imperceptible, the action of the heart tumultuous but feeble, and the respiration difficult and oppressed. Death may occur immediately, but more commonly after an interval varying from a few minutes to an hour or more; or, if the quantity of air introduced be but small, recovery may gradually ensue, partial paralysis sometimes continuing for several hours or even a much longer time subsequent to the accident.

The *cause of death* in these cases is somewhat obscure; Mr. Erichsen believes it to be the frothy condition of the blood, produced by the action of the heart, which prevents the due transfer of the circulating fluid through the pulmonary tissue, and thus secondarily causes a deficient supply of blood to the brain and nerve centres, inducing death by syncope. Sir Charles Bell believed that death was caused by the direct transference of air to the base of the brain, and, in confirmation of this view, Prof. Gross's observation may be referred to, viz., that animals may be rapidly killed by the injection of air into the carotid artery. Dr. Cormack attributed the fatal result directly to paralysis of the right side of the heart from gaseous distention, while Mr. Moore maintained that death was due to the entrance of air to the heart, impeding the action of the cardiac valves and thus stopping the circulation, a view which has recently received experimental confirmation from M. Couty. Other experiments also, by Kowalewsky and Wyssotsky, show that frothy blood accumulates in the right side of the heart, mechanically hindering the normal circulation, and thus causing death by anæmia of the aortic system.

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[1] It is probable, also, that the entrance of air into the uterine veins is an occasional cause of sudden death after delivery, and after various operations upon the womb. (See an able paper by Dr. Greene, of Dorchester, in *Amer. Journ. of Med. Sciences* for Jan., 1864, pp. 38–65.)

Treatment.—As a *preventive* measure, the surgeon should exercise extreme caution in all operations about the root of the neck, or deep in the axilla, using as much as possible the handle instead of the blade of his knife. It might also be desirable to have the large veins compressed by an assistant, or protected by serre-fines, between the seat of the operation and the heart, and care should be taken not to place the veins in such a position as will prevent them from collapsing if wounded, whether by stretching the patient's head to the opposite side, by hastily elevating the shoulder, or by incautiously lifting a tumor from its bed. Mr. Erichsen recommends that the patient's chest should be swathed by a firm and broad bandage, as a precautionary measure, so as to limit as far as possible the depth of the inspirations. Should a large vein in the "dangerous region" be wounded during an operation, or should the surgeon find such a wound in a case of cut-throat, etc., measures should instantly be taken to prevent the entrance of air, by the application of ligatures above and below the aperture. When this alarming accident has actually occurred, the first indication for treatment is obviously to prevent any further ingress of air, by making instant compression and then quickly applying a ligature. The *lateral* ligature was successfully employed in a case recently recorded by Lange, of New York. The subsequent treatment must consist chiefly in endeavoring to keep up the action of the heart by appropriate means. Of these, the most promising appear to me to be artificial respiration and the administration of stimulants. The patient should be in the recumbent position, and the extremities elevated so as to retain as much blood as possible in the central organs; to accomplish the same purpose, Mercier advised the application of tourniquets and compression of the abdominal aorta. Artificial respiration may be practised with suitable bellows, or simply by the surgeon's mouth. Sylvester's or Hall's method would scarcely be applicable in these cases, on account of the situation of the wound. The administration of oxygen gas by inhalation is recommended by Walsham and Couty, the latter of whom also advises venesection. Various other plans have been suggested, among which may be mentioned—(1) an attempt to suck out the air by means of a canula introduced into the wounded vein, into the right jugular vein, or even into the heart itself; (2) bleeding from the right jugular vein or from the temporal artery; (3) tracheotomy; and (4) the injection of warm water into the heart. I am not aware, however, that there are any cases on record which prove the efficiency of any of these methods. Galvanism might rationally be applied to the cardiac region, though I should be disposed to trust more to the use of stimulants and to artificial respiration.

Remote Consequences of Injuries of Veins.—A clot may form in a vein as the result of injury (*thrombosis*), and may subsequently undergo disintegration, the fragments being carried to the right side of the heart and thence to the lungs, plugging the minute pulmonary arteries (*embolism*), and thus giving rise to the formation of what are commonly but incorrectly called metastatic abscesses. This condition, which is in no degree necessarily connected with phlebitis, will be again referred to in the chapter on pyæmia.

On the other hand, a clot in a vein may undergo a process of gradual contraction, induration, and decolorization, becoming finally calcified, and constituting what is called a *phlebolite*, or *vein-stone*. These phlebolites, however, usually result from clots due to stagnation, without external violence, and are consequently chiefly met with in the veins of the pelvis, genital organs, and lower extremities.

Injuries of Arteries.

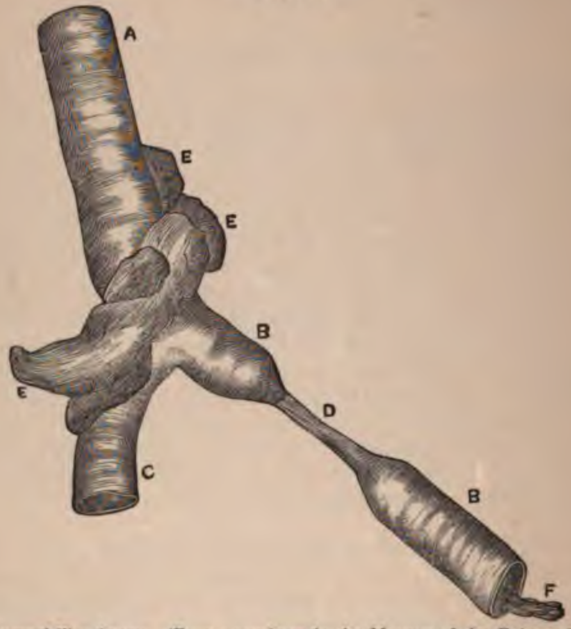
Contusion of an Artery may exist, without giving at first any evidence of its occurrence. The secondary results of arterial contusion depend upon the severity of the injury; if this have been very great, a portion of the wall of the vessel may slough, and cause secondary hemorrhage or extravasation; if the violence have been less, the vessel may undergo obliteration, or in very slight cases may recover without evil consequences. The obliteration of an artery, occurring some hours or days after the reception of an injury, is usually attributed to the effect of inflammation; I believe, however, that it is more commonly due to the plugging of the vessel, either by embolism (fragments of clot being carried from another part of the circulation), or more rarely to an actual thrombosis *in situ*, clotting taking place in the injured vessel itself. As a result of this obliteration, or *infarctus* as it is called by French writers, gangrene or serious visceral degeneration may occur, according to the size and situation of the vessel. Thus, in two cases of injury in the lumbar region, Dr. Moxon found complete thrombosis of the renal arteries, with corresponding incipient degeneration of the kidneys.

Rupture or Laceration of an Artery may be either partial or complete; *partial laceration* generally occurs without external wound, and involves the two inner coats of the artery, the elasticity of the outer coat preserving it from injury. This accident may form the starting-point for the development of an aneurism at a subsequent period; or the torn inner coats of the vessel, curling upon themselves, may furnish a nidus for the occurrence of coagulation, which, as in the case of contusion, may cause gangrene of the part below the seat of injury; or, again, the lacerated inner coats may turn downwards, and by their mechanical valvular action produce gangrene, by directly interfering with the circulation. Finally, a partial laceration may, after a longer or shorter interval, become complete, when death from internal hemorrhage may follow, as in a case of rupture of the external iliac artery observed by myself at the Episcopal Hospital. (Fig. 81.) *Complete rupture* may occur subcutaneously, or in an open wound. In the latter case, the nature of the accident may be obvious from the profuse arterial bleeding, though in other instances, if the coats of the vessel are twisted upon themselves, there may be scarcely any hemorrhage, the artery, perhaps, hanging out of the wound and pulsating, and yet no blood escaping. When an artery is torn across subcutaneously, there may be wide-spread extravasation, or the development of one or other form of traumatic aneurism, according to the size and position of the vessel.

Wounds of Arteries.—*Non-penetrating wounds* of arteries occasionally, but very rarely, occur. In these, the external coat is divided, with, perhaps, a portion of the middle coat. There is no primary hemorrhage in these cases, but the inner coat almost invariably yields after a few days, when fatal bleeding may ensue. Hence, a partially divided artery should always be ligated, as a precautionary measure.

Penetrating wounds of arteries, if very small (consisting of a mere puncture with a fine needle), may not be productive of evil consequences; but if the puncture be larger, as with a tenaculum, secondary, if not primary, hemorrhage will almost certainly follow. Incised wounds of arteries bleed more or less freely, according to the size and direction of the wound; thus, a longitudinal wound will, in consequence of the anatomical arrangement of the arterial coats, gape less, and consequently bleed less, than one which has an oblique direction, while a transverse wound will bleed more than either. An artery which is completely cut across bleeds less, other things being equal, than one which is only partially divided; for the complete section of the vessel allows partial retraction and contraction to occur, and thus measurably lessens the size of the stream. A wound of an artery at the bottom of a narrow and tortuous passage through muscular or other tissue, approaches to the nature of a subcutaneous laceration, and extensive extravasation may then occur with very little external bleeding; or the outer wound may actually heal, while the opening in the vessel remains patulous, in which case a form of traumatic aneurism may be developed.

FIG. 81.



Rupture of External Iliac Artery. (From a specimen in the Museum of the Episcopal Hospital.) A. Common iliac artery. B. External iliac artery. C. Internal iliac artery. D. Position of rupture. E. Clot overlying common trunk. F. Clot protruding from distal end of external iliac artery.

Hemorrhage from a Wounded Artery may usually be recognized by the bright vermilion hue of the effused blood, and by the fact that it is thrown out in jets corresponding to the pulsations of the heart, and does not flow in an even stream, as in cases of hemorrhage from veins. To this rule there are, however, exceptions; the blood from the proximal end of a divided artery always, I believe, presents the characters which have been described, but from the distal end, for at least an hour after the infliction of the wound, or until the collateral circulation has been established, the flow of blood resembles that from a wounded vein. In other cases, however, if the anastomosis be very free, as in the palmar arch, both ends of the cut vessel will bleed in jets, and pour out blood of a bright red color. The force of the jet varies with the size and position of the artery and the strength of the heart's action. A small branch wounded in close proximity to a main trunk, may bleed more furiously than a larger vessel divided at a more distant point, and, in general terms, the nearer a cut vessel is to the centre of circulation, the more profusely will it bleed. As the pulsations of the heart become weaker, the jet of blood has less force, and may finally cease with the occurrence of syncope, or may be arrested by the natural processes of contraction and retraction which are set up in the wounded vessel.

As already indicated, there may be profuse bleeding without any external loss of blood. When bleeding occurs into one of the cavities of the body, as the peritoneal, it constitutes *internal* or *concealed hemorrhage;* when into the areolar tissue of a part, it is known as *extravasation.* Extravasation may prove directly fatal, by the amount of blood abstracted from the general circulation, may cause gangrene by pressure, especially upon the neighboring venous trunks, or, if circumscribed, may give rise to a form of traumatic aneurism.

Constitutional Effects of Hemorrhage.—These are the same in kind, though differing in intensity, whether the bleeding proceed from arteries or veins, and whether the hemorrhage be apparent or concealed. The first effect of profuse hemorrhage is shown in the blanching of the surface; the cheeks and lips become pale, and the conjunctiva unnaturally white. The pulse becomes small and rapid, the heart endeavoring by increased action to compensate for diminished power. The patient feels languid; the respiration assumes a sighing character; the senses of sight and hearing are perverted, being sometimes preternaturally acute, but more often dulled; the temples throb, the skin becomes cold, and at last, rather suddenly, the patient faints. During the state of syncope, the heart's action is very feeble, and the breathing almost entirely diaphragmatic. Death may occur in this condition from a continuance of the hemorrhage, but more commonly coagulation takes place in and around the mouth of the wounded vessel, and when consciousness returns, the bleeding is found to have spontaneously ceased. Vomiting frequently occurs as syncope passes off. All the tissues of a patient who has lost much blood appear soft and flabby, probably from the loss of the natural fluids of the part, which are rapidly absorbed into the depleted bloodvessels. Profuse or repeated hemorrhage, beside the symptoms which have been above described, often gives rise to distressing nervous phenomena, such as amaurosis, delirium, convulsions, or even hemiplegia; I have known death attributed to a cerebral clot, which the autopsy showed did not exist, the fatal result being simply and altogether owing to profuse and repeated secondary hemorrhages. In recovering from the effects of loss of blood, the patient sometimes passes through a condition of constitutional irritation, with extreme restlessness and delirium, to which the name of "*hemorrhagic fever*" has not been inaptly applied.

The amount of blood which can be lost without serious consequences ensuing, varies greatly in different individuals. Infants and very old persons are, as a rule, more injuriously affected by hemorrhage than those in middle life. The amount of blood lost in ordinary childbirth might produce serious consequences under different circumstances, while, on the other hand, the mental state of a patient, as of one who has attempted suicide, or who believes himself to be bleeding to death, may actually cause a fatal result after the loss of a really insignificant quantity of blood.

Habitual or *Periodic Hemorrhage* may be met with in either sex. In the female it may take the place of, or alternate with, the natural menstrual flow, when it constitutes what is called *vicarious menstruation*. In the male sex, bleeding from the hemorrhoidal veins sometimes occurs at certain periods of the year, and seems to be occasionally beneficial by relieving a state of plethora. Some persons bleed habitually from the nose, without any apparent solution of continuity having taken place; and Mr. Moore mentions an apparently authentic case, in which a young woman had severe spontaneous hemorrhages from the skin of the finger. In these cases the blood seems to ooze from numerous minute orifices, and subsequently to collect in the form of drops, which then flow over the surface.

Hemorrhagic Diathesis; **Hæmophilia.**—These are the names used in England and in this country for the remarkable affection which the French call *Hémophylie*, and the Germans *Hämophilie* or *Bluterkrankheit*. Its chief manifestation, and that from which its name is derived, is a disposition to profuse bleeding, which may be spontaneous, or may follow upon the slightest wounds. It is often hereditary, and those in whom it exists are in childhood often subject to affections of the joints, and to inflammations of the lungs. It affects almost exclusively persons of the male sex, the female members of a family, though transmitting it to their posterity, being themselves usually exempt. The disease appears to depend on a peculiar condition of the blood (not mere want of plasticity, for it coagulates readily when removed from the body), and on a defective contractility of the arteries and capillaries. P. Kidd has observed, after death, great proliferation of the epithelioid cells lining the small vessels, with degeneration of their muscular coat. According to Wachsmuth, the spontaneous hemorrhages may often be averted by smart purging with Glauber's salts, and, when they occur, may best be arrested by the administration of an infusion of arnica, or ergot in doses of five grains every half hour. The hemorrhages which follow wounds do not yield so readily to constitutional measures, and in these cases long-continued pressure, and the use of the actual cautery, appear to be the most promising modes of treatment. The existence of the hemorrhagic diathesis would of course be a contra-indication to the performance of any operation involving the use of the knife; it is somewhat remarkable, however, that cases which have proved fatal, from this cause, have almost invariably been those of trivial accidental wounds, or of such slight surgical procedures as the extraction of a tooth, or lancing the gum—the only recorded instance, as far as I know, of the hemorrhagic diathesis having caused death after an important operation, being in a case of lithotomy reported by Mr. Durham.

Process of Nature in Arresting Hemorrhage.—Before entering upon the subject of the treatment of arterial hemorrhage, it will be necessary to consider briefly the process adopted by nature in closing wounds of these vessels, a process which the surgeon endeavors to imitate by the appliances of art. The natural means by which arterial wounds are healed have been experimentally and very thoroughly investigated by Dr. J. F. D. Jones, whose monograph on the subject was published more than sixty years ago, since which time very little, if anything, has been added to our information concerning the matter. The *temporary* means employed by nature to arrest hemorrhage are twofold: (1) the formation of a clot, and (2) the contraction and retraction of the cut end of the vessel itself. The formation of a clot, which is greatly facilitated by the diminished force of the heart's action (one of the constitutional effects of hemorrhage, as we have already seen), was first noticed and its importance pointed out by the celebrated French surgeon Petit, in 1731. This distinguished writer described an external clot which he called *couvercle*, and an internal clot which he called *bouchon*. The internal clot is somewhat conical in form, its base adhering to the sides of the vessel near its cut extremity, and its apex reaching upwards, usually as high as the origin of the first anastomosing branch. It is formed gradually, and having served its temporary purpose, undergoes contraction and partial absorption, and eventually appears to form a portion of the fibrous cord into which a closed artery is converted. The contraction of a divided artery, and its retraction within its sheath, begin immediately upon its division; this step of the process was first indicated by Morand, in 1736, who did not deny, as some of his followers have done, that the formation of a clot is of temporary utility, though he clearly declared his conviction that the permanent closure of the vessel must depend upon the cicatrization of the artery itself. The retraction of the vessel within its sheath allows the blood to come in contact with the irregular surface of the latter, and thus facilitates the formation of the external coagulum, while its contraction as regards its calibre diminishes the size of the stream, and thus tends to assist the formation of the internal clot, of which it likewise determines the shape. This contraction, as shown by Kirkland, extends to the origin of the nearest anastomosing branch. The *permanent* means by which a divided artery is closed, consist in the union of the cut edges by the development of local inflammatory changes, the continued contraction of the walls of the vessel upon the internal coagulum, and the final conversion of the lower end of the vessel into a dense, fibrous, impervious cord, into the construction of which a certain portion of the internal clot appears usually to enter. The exact mode in which the cicatrization of the cut extremity of the vessel is effected, is variously described by authors, according to the several views entertained as to the nature of the inflammatory process (see Chap. I.). Most surgical writers, following Dr. Jones, have attributed the healing of divided arteries to the effusion of *plastic matter* from the *vasa vasorum;* the advocates of the cellular pathology consider the process to be one of *cell proliferation* from the vessel's walls, a view which is sustained by careful experiments made by Dr. Shakespeare, of this city; Prof. Beale and Mr. Lee consider the union to be due to the development of *germinal matter*, derived from the white corpuscles of the blood, while Billroth (practically returning to the old doctrine of Petit), attributes the healing of wounds of both arteries and veins to the *organization of the internal coagulum*, through the multiplication of the white blood-corpuscles, aided, perhaps, by the entrance of wandering cells from the surrounding tissues.

Without entering into a discussion of this question, which must be considered to a great degree one of purely theoretical interest, I may say that whatever be the method by which injuries of other tissues are repaired, by the same method, in all probability, are wounds of arteries united; and this method, as I have endeavored to show in previous chapters, is in all cases by means of that natural process which for want of a better name we call inflammation. We may, however, from what has been said, derive this practical lesson: that as the repair of an artery after injury appears to require the co-operation both of the walls of the vessel and of the contained blood, no means of arresting hemorrhage can be looked upon as philosophical, which ignores the efficiency and attempts to dispense with the aid of either of these agents. The application of this remark will be seen directly, when I come to speak of the local means of treating arterial hemorrhage.

The changes which have been above described are best marked in the closure of the *proximal* or *cardiac* end of a divided artery. Those which take place in the *distal* extremity are the same in kind, though less in degree; especially is this the case as regards the internal coagulum, which in the distal end of the vessel is smaller than in the proximal, and indeed in some cases entirely deficient; a circumstance which, as pointed out by Guthrie, may probably account for a fact which has long been recognized by surgeons, that secondary hemorrhage usually occurs from the distal extremity of a wounded vessel.

In the case of partially divided arteries, the process is essentially the same; a clot forms between the sheath and the vessel itself, and compresses the latter; this pressure may likewise be aided by the formation of a clot in the external wound. The permanent closure of the arterial incision is effected, as in the case of complete division, by the inflammatory process. Very slight wounds, especially if longitudinal, may close without the calibre of the artery being obliterated; if, however, the size of the wound be equal to one-fourth of the circumference of the vessel, the latter will almost inevitably be converted into an impervious cord at the seat of injury, and it is probable that, in these cases, the healing process is assisted by the formation of an internal, as well as an external, coagulum. When such a wound heals without the obliteration of the calibre of the artery, the inner coats of the latter do not unite very firmly, and an aneurism is apt to be subsequently developed. In an artery as large as the axillary or femoral, it may be stated, in general terms, that a wound of one-fourth of the circumference of the vessel will, if untreated, either cause death by hemorrhage, or give rise to a traumatic aneurism; in the rare instances in which neither of these consequences ensues, the vessel will, in healing, be converted into an impervious fibrous cord.

TREATMENT OF ARTERIAL HEMORRHAGE.

The treatment of arterial hemorrhage should be both *local* and *constitutional*. The **constitutional treatment** consists in keeping the patient quiet in a recumbent position, and in avoiding any sudden elevation of the head or of the arms, which might induce fatal syncope. Food and stimulants should be cautiously administered in small quantities at a time, and, if there be vomiting, may be given by enema. Hypodermic injections of ether have been successfully used by Hecker, Macan, and others, in the collapse of post-partum hemorrhage, and I have myself employed them with advantage in cases of profuse bleeding during operations. Opium should be freely used, and is a most valuable remedy in these cases. Drugs adapted to increase the plasticity of the blood, such as the muriated tincture of iron or the acetate of lead, may be administered, or ergot may be used, as recommended by Wachsmuth in cases of the hemorrhagic diathesis. As a last resort *transfusion of blood* should certainly be tried, in the manner and with the precautions recommended in Chapter IV. The statistics of this operation in cases of hemorrhage, as given by Landois, are very favorable, 99 cases having afforded not less than 65 recoveries, while 11 of the 31 fatal cases (the result in 3 was doubtful) were moribund at the time transfusion was practised. Stricker recommends vigorous kneading of the abdomen, so as to force the blood from the abdominal veins to the heart, and thus keep up the action of that organ. For the anæmia left after recovery from the primary effects of hemorrhage, a long course of tonics, and especially of the preparations of iron, may be required. The loss of blood in some cases is never entirely repaired during life, the patient remaining permanently blanched, though otherwise apparently in good health; or the debility resulting from hemorrhage may act as a predisposing cause for the occurrence of tuberculosis or other morbid condition. The **local treatment** of arterial bleeding consists in the adoption of various measures, which may be either of a *temporary*, or of a *permanent* nature. Hemorrhage from a wounded artery may be *temporarily* checked by *pressure*. This may be applied *directly* at the seat of injury, or *indirectly* upon the main artery of the part, at a point between the wound and the centre of the circulation. In the latter case compression is usually best exercised by the application of the tourniquet, the various forms of, and the modes of using, which instrument have been sufficiently described in a previous chapter. In dealing with certain arteries, as the subclavian, to which a tourniquet cannot be applied, effectual pressure may be made with the handle of a large key (previously wrapped, so as to protect the skin), or other suitable implement; or if the clavicle be much displaced—as by an aneurismal tumor—Syme's plan might be employed, which consists in making an incision in the line of the artery, upon which direct pressure is then made by introducing the finger through the wound. For the *permanent* arrest of arterial hemorrhage, the surgeon may have recourse to the use of—1, *cold*; 2, *position*; 3, *pressure*; 4, *styptics*; 5, *cauterization*; 6, *torsion*; 7, *ligation*; or 8, *acupressure*.

1. **Cold** is an efficient means of arresting hemorrhage from many vessels of small calibre. In some cases the presence of clotted blood in a wound appears to encourage further bleeding by acting just as a warm poultice would do, and the surgeon often finds that, upon sweeping away the clots and exposing the wound to the air, the hemorrhage ceases spontaneously. Hemorrhage from small vessels may often be arrested by pouring a stream of cold water over the part, or if the bleeding come from one of the mucous outlets of the body, as the mouth, nostrils, rectum, or vagina, by introducing small pieces of ice. Care must be taken, however, in the use of cold, not to continue its application too long, lest injurious depression or even sloughing should ensue. The application of *hot water* has been successfully employed in cases of capillary hemorrhage by Keetley, C. T. Hunter, and other surgeons.

2. **Position** may often be usefully employed to arrest, or, at any rate, to assist in arresting arterial hemorrhage. If the wound be in the lower limb, the part should be elevated by means of pillows or an inclined plane, so that, by the laws of hydraulics, the force of the circulation in the injured part may be diminished, and an opportunity given for the occurrence of the natural processes of repair. The same plan may be adopted for wounds of the upper extremity; while in treating wounds of the arteries of the forearm or of the palmar arch, it will be found advantageous to forcibly flex the elbow—a modification of Hart's method of treating aneurism, which has afforded good results on more than one occasion.

3. **Pressure**, which, as we have seen, is the common mode of temporarily checking hemorrhage, may be also efficiently used for its permanent arrest. It may be applied *directly* to the bleeding point by means of the graduated compress, or by the use of serre-fines, or of small forceps; or *indirectly*, by bandaging the limb and flexing the proximal joint over a roller, or, in the case of bleeding from cavities, by plugging the part with lint or compressed sponge. Sometimes pressure may be efficiently applied by means of a weight, as a bag of shot, or even loose shot, as was done in Dr. Smyth's remarkable case of successful ligation of the innominate artery, which will be again referred to. The *graduated compress* is made by laying together a number of

pledgets of lint of gradually increasing dimensions, so that when completed the mass has the form of an inverted cone about an inch in height; the apex of this cone is applied directly upon the bleeding point, all clots having been previously removed from the wound, and the compress is held in place by adhesive strips, while firm pressure is made upon it by means of a piece of cork or metal, secured with a bandage. In positions where the proximity of a bone gives a firm substance against which the vessel may be compressed, as in the case of wounds of the temporal artery, this will be found a very efficient mode of controlling hemorrhage.

4. **Styptics.**—These agents, when employed alone, are not of much use, except in checking capillary oozing or the bleeding from very small vessels. The simplest and most convenient is ordinary diluted alcohol, the employment of which in operations has already been adverted to. The styptic of Pagliari, which has a good deal of reputation, particularly among French surgeons, contains alum and benzoin, and certainly seems in some cases to answer a very good purpose. Among the more powerful styptics may be especially mentioned the perchloride of iron, in substance, in solution, or in the form of the muriated tincture, and the persulphate, or Monsel's salt. The latter, in particular, is undoubtedly a very powerful agent, and, when properly used, capable of serving a very good end; its indiscriminate employment in all cases of surgical hemorrhage has, however, been productive of a great deal of harm, not only on account of its effect in hindering primary union, but because the rapidity of its action, and the facility with which it can be applied, have often induced inexperienced practitioners to neglect less easy but more trustworthy means of suppressing arterial bleeding.

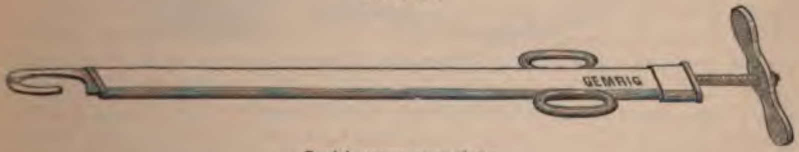
In conjunction with *pressure*, styptics are more valuable than by themselves; by applying the styptic upon the apex of the graduated compress, or, in the case of hemorrhage from deep fistulous wounds, or from the mucous outlets of the body, by plugging the cavity with lint or sponge soaked in the styptic, a very powerful impression may be produced. In a very interesting if inconclusive paper, published in the *American Journal of Medical Sciences* for October, 1865, Dr. J. M. Holloway advocates the employment of styptics, with pressure, in cases of consecutive hemorrhage from gunshot wounds, as often preferable to the use of the ligature; and though, of course, a practice founded on universal experience is not to be revolutionized by the record of a few exceptional cases met with by any individual, still the instances mentioned by Dr. Holloway are of much interest, as showing that these means may occasionally prove successful even in dealing with such a large artery as the axillary. For bleeding after the extraction of a tooth, Moreau recommends plugging the cavity with cotton saturated with tincture of benzoin, and compression by means of a piece of cork fixed between the neighboring teeth.

5. **Cauterization** with a hot iron was, until within a comparatively short period, the principal means of arresting arterial bleeding at the command of the surgeon. Although the ligature was re-invented and powerfully advocated by the illustrious Paré, in the middle of the sixteenth century, it was not generally adopted for a long time subsequently, and we learn from the writings of Sharpe, of Guy's Hospital, only a little more than one hundred years ago, that even in his time the cautery and styptics were still preferred to the ligature by many surgeons, not only on the Continent, but even in some parts of England. Although no surgeon at the present day, probably, would use the hot iron in any case in which a ligature could be applied, there are some circumstances under which the cautery must still be resorted to; in some operations about the jaws, and in other cases in which,

from the position of the bleeding vessel, or from the condition of the surrounding tissues, other modes of controlling hemorrhage are not available, or fail upon trial, the hot iron is a valuable application. The various forms of the cautery have already been described and figured in the chapter on Minor Surgery, and it will be sufficient to add here that when used for hemorrhage, as it is the coagulant and not the destructive effect that is needed, the temperature of the iron should not be raised above a *black heat.*

6. **Torsion,** as a means of controlling the hemorrhage from cut arteries, was known to the ancients, but subsequently passed through a long period of oblivion, having been revived in the early part of this century, principally by the efforts of French and German surgeons, among whom may be specially named Amussat, Velpeau, and Fricke. Since then torsion has been occasionally used by surgeons, generally in dealing with small arteries; but the practice has within a few years received a fresh impulse, and is now strongly advocated by several writers as a mode of treatment applicable to vessels of all sizes; this movement has been most actively participated in by Prof. Syme, of Edinburgh, Prof. Humphry, of Cambridge, and Messrs. Bryant and Forster, of Guy's Hospital, London. Torsion may be practised in several ways: Syme, Humphry, and Tillaux, following Amussat, draw the extremity of the artery out from its sheath, and twist it until it is twisted off; the surgeons of Guy's Hospital, on the other hand, adopt Velpeau's plan of leaving the twisted end attached, that it may give additional security by acting as a mechanical plug. *Free* torsion (that is, with a single pair of forceps) is recommended by Bryant for vessels of moderate size, and for all vessels in the extremities; *limited* torsion (in which the vessel is grasped with one pair of forceps and twisted with another) for such arteries as are large and loosely connected. An ingenious torsion-forceps has been devised by Dr. Hewson, of this city. When it is not intended to twist off the end of the vessel, the number of turns should vary from six to eight, according to the size of the artery. The mechanism of torsion is as follows: the inner and middle coats are lacerated and curl upon themselves, forming a nidus for the coagulation of blood, just as after ligation, or in the ordinary natural process of repair already described; the external coat is twisted into a cord, which serves temporarily as a mechanical plug, and is eventually surrounded by lymph and incorporated with the adjoining tissues, or more commonly separated and thrown off by sloughing, just as the end of a vessel which has been submitted to the ligature. The artery is permanently closed by the inflammatory process, at the point at which the middle and inner coats have given way. Torsion has now been so often successfully applied, even to large vessels, that it cannot, I think, any longer reasonably be doubted that it is an effectual mode of controlling hemorrhage; it is, according to Forster and H. Lee, even more applicable to large vessels than to small. I do not see, however, that it is at all a better mode than ligation, nor, I think, does it equal the latter in safety; this point will be again referred to after I have described the remaining modes

FIG. 82.

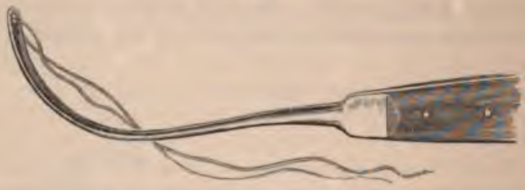


Speir's artery constrictor.

of controlling hemorrhage, ligation, and acupressure. A modification of the ordinary mode of effecting torsion has been recently suggested by Dr. S. Fleet Speir, of New York, who employs an instrument which he calls the "*artery constrictor*" (Fig. 82); its action somewhat resembles that of the écraseur, and it is designed to sever the internal and middle coats of the artery, thus allowing their invagination within the external coat, which is corrugated but not divided. The instrument is removed as soon as this has been accomplished.

7. **Ligation.**—The use of the ligature, though apparently known to the ancients, was afterwards completely forgotten, so that its introduction into surgery by Paré, in the sixteenth century, has all the merit of an original discovery. It was not, however, until long after Paré's time that the use of the ligature became universal, or indeed general; and the reason for this appears to have been not so much on account of innate obstinacy on the part of surgeons, as because the natural process by which hemorrhage is arrested not being understood, and ligation being consequently practised in a very defective manner, its results were correspondingly unsatisfactory. The ligature, as now used, is, I believe, when applicable, the very best method of checking arterial hemorrhage. The form and structure of the ligature, and its mode of application to the open ends of vessels, have already been described (page 98), and need not be again adverted to. When it is necessary to secure an artery in its continuity, the ligature may be most conveniently passed beneath the vessel by means of an aneurismal needle (Fig. 83), or even an ordinary curved needle, or an eyed probe. The *mechanism* of the ligature in controlling hemorrhage is now well understood (thanks to the investigations of Dr. Jones), and the rules for its application thoroughly established. The illustrious John Hunter, even, did not appreciate the mode of action of the ligature, and accordingly we find that in his operations for aneurism he did not draw the noose tight, fearing to weaken the coats of the vessel—thus, as Dr. Jones subsequently showed, defeating the very object sought to be attained. The ligature should be applied with sufficient force to divide, smoothly and evenly, the inner and middle coats of the artery, while the outer coat is constricted within the noose. In tying the larger vessels, the giving way of the inner tunics of the artery is sometimes distinctly perceptible to the surgeon. The divided inner coats curl upon themselves, and assist the formation of an internal coagulum, while the artery is permanently sealed by the occurrence of inflammatory changes, just as in the natural hæmostatic process already described. The noose of the ligature is gradually loosened by ulceration, and finally cuts its way through, or comes out bringing with it the constricted portion of the external arterial coat. The clot which is formed on the distal side of the ligature is usually smaller than that on its proximal side; in some cases one or even both clots may be absent,

FIG. 83.



Aneurismal needle, armed with a ligature.

and yet the artery be securely closed, which shows that the formation of a clot, though of great assistance, is not in all cases absolutely essential for the success of the ligature. Dr. B. Howard, of New York, has published some experiments to show that it is not invariably necessary to draw the ligature so tight as to divide the inner coats, but that mere narrowing of the arterial tube with a loose ligature is sufficient sometimes to secure obliteration of the vessel. This (which is a revival of the teaching of Scarpa) was indeed known from the cases of Hunter, who, as we have seen, did not tighten his ligatures in operating for aneurism; but I am not aware of any clinical facts which show that a loose ligature has any superiority over a tight one, while the universal experience of surgeons is that it is less safe, and that it has the additional disadvantage of not coming away as readily as one which is tightly drawn.

The best material for a ligature is, as has been already said, ordinary fine whip-cord or silk. Various attempts have been made from time to time to substitute other materials which it has been supposed would produce less irritation and might become encysted or absorbed. Thus Sir Astley Cooper and Dr. Physick made use of *animal ligatures*, catgut or some similar substance, and this practice has since been occasionally adopted by others.[1] *Carbolized catgut* has been recently extensively employed by Lister and other surgeons, but has not proved itself as certain a preventive of secondary hemorrhage as was at first anticipated. Its fault is, it seems to me, that it disappears without dividing the external coat of the artery, and thus does not securely occlude the vessel—in this respect being open to the same objection as acupressure. *Metallic ligatures* were employed in a series of experiments on the lower animals by Dr. Levert, of Alabama, about forty years ago, and since then have been occasionally used in operations on the human subject. Dr. Levert found that wire ligatures tightly secured around the arteries of dogs, produced obliteration of the vessels, and that, when both ends of the ligature were cut short, the loop became encysted, and remained in the wound an indefinite time without producing irritation. Similar results have been since obtained by Sir J. Y. Simpson and others. Dr. Howard, on the other hand, finds that wire ligatures, if drawn tight, produce marked inflammation and suppuration around the seat of ligation, and therefore recommends the use of *loose* wire ligatures. Metallic ligature threads have now been used a sufficient number of times in operations on the human subject, by Stone, Gross, Mastin, and other surgeons, to warrant the belief that they are safe agents, and may properly be applied in cases in which it is desirable to leave the noose *in situ* and close the wound over it, as in certain operations upon the abdominal cavity; even in these cases, however, it is probable that the antiseptic short-cut ligature of Prof. Lister would answer a still better purpose.

Rules for Ligating Wounded Arteries.—In the application of ligatures to wounded arteries, there are certain rules which should be indelibly impressed upon the surgeon's mind: these are—

1. *In cases of primary hemorrhage, no operation should be performed upon an artery, unless it is at the moment actually bleeding.* In cases of *secondary* hemorrhage, a different practice should be adopted, as will be presently seen; but in dealing with a recently wounded artery, if hemorrhage have ceased, the surgeon as a rule should not interfere, because (1) there is a fair

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[1] The late Prof. Eve employed ligatures made from the sinew of a deer, and Mr. Barwell recommends those taken from the middle coat of the ox's aorta. Mr. T. Smith, Mr. Croft, and Mr. Pollock have used carbolized ligatures made from the tendon of the kangaroo.

prospect that the bleeding will not return; (2) the probability of discovering the source of hemorrhage is much less, when there is no stream of blood to point the surgeon's way, and (3) the incisions and manipulations which would be necessary in searching for the arterial wound would be a positive injury which would more than counterbalance any benefit that might probably be obtained. In certain exceptional cases, however, the surgeon should not hesitate to apply a ligature even under these circumstances; for instance, if an artery were seen pulsating in a wound, it would be right to tie it even though it did not bleed, for in such a case the ligature could do no harm, and might prevent a great deal of subsequent mischief; again, if a patient were likely, for any reason, to be subjected to unusual risk of secondary hemorrhage, as, for instance, if it were necessary for him to be transported to a distance, or if he were threatened with the invasion of delirium tremens, it might be proper to choose the lesser evil, and search for the wounded vessel, that it might be secured by a ligature. Under any circumstances the patient should be constantly watched, and if the wound were in an extremity, it would be right to apply a provisional tourniquet, so that, in case of secondary hemorrhage, all unnecessary loss of blood might be prevented.

2. *In applying a ligature to a wounded artery, the surgeon should cut down upon it directly at the point from which it bleeds, and secure the vessel in the wound.* This rule and the next were clearly laid down by John Bell, and most powerfully enforced by Guthrie, and yet, it is to be feared, are, even at the present day, too often practically ignored by operators. There are two principal reasons why this rule should be considered invariable: (1) because it is often impossible to tell what vessel is wounded, until it is exposed in the wound itself; and (2) because, even if this point could be determined, ligature of the main trunk above the wound would, in a vast number if not in the majority of cases, fail to arrest the bleeding. Thus it has happened that the superficial femoral artery has been tied for arterial hemorrhage from a wound of the thigh, and, bleeding continuing or recurring, it has been subsequently discovered that it was a branch of the profunda that was wounded; or the subclavian has been tied for supposed wound of the axillary artery, when the hemorrhage really came from the long thoracic. Again, if the main trunk be tied, the collateral circulation being quickly established, secondary hemorrhage is extremely apt to occur from the *distal* side of the arterial wound; or if there be collateral branches given off between the point of ligation and the wound, bleeding may occur even from the *proximal* side of the latter, when, if a second ligature be applied in the wound, the double obstruction will (at least in the lower extremity) almost invariably cause gangrene of the limb. Still further, deligation of the main trunk exposes the patient sometimes to additional danger; thus, Liston having tied the external iliac for wound of a small branch of the common femoral, the patient died of peritonitis, a cause of death, it will be observed, which was directly connected with the operation, and entirely independent of the original injury. For these reasons, then, viz., that by this method only can the actual source of hemorrhage be determined; that thus only can probable security be afforded against secondary bleeding; that if secondary hemorrhage should occur, this plan does not put out of the question further treatment; and that this plan does not entail any additional risk upon the patient, the rule should be invariable, that, *whenever practicable, a bleeding artery should be directly cut down upon, and tied where it bleeds.* In doing this, the surgeon should usually take the original wound as the guide for his incisions; should, however, the wound be very deep, it may be more convenient to reach the source of hemorrhage by making a counter-incision in the course of the vessels, cutting upon the end of a probe introduced to

the bottom of the wound. *Hemorrhage during the operation* should be guarded against by the use of a tourniquet, where this instrument is applicable, or by pressure made by an assistant on the main trunk; in situations where this is impracticable, the surgeon should introduce one or two fingers into the wound, so as to compress the bleeding vessel while making the necessary incisions. This rule of tying an artery where it bleeds holds good for both primary and secondary hemorrhage; no matter what the condition of the wound may be, as long as there is a wound, it should be freely enlarged, and the vessel secured at the point whence the blood issues. This is often a difficult and tedious proceeding, particularly in wounds that are swollen and granulating, but it is a proceeding that the surgeon should consider imperative when the occasion arises; and it is surely very reprehensible for any operator, in view of the vast accumulation of recorded experience on the subject from both civil and military practice, to persist in cases of arterial hemorrhage in tying the main trunk of a limb, merely because it is easier than to tie the vessel in the wound, or, still worse, because it enables him to perform what is considered a more important operation.

3. A third rule, and one closely connected with the preceding, is that *two ligatures should be applied, one to each end of the artery if it be completely divided, and one on each side of the wound, if the latter have not completely severed the coats of the vessel.* The reason for this rule is obvious: in many parts of the body the arterial anastomosis is so free that a ligature to the proximal side alone will not even temporarily arrest the bleeding, the current of blood being immediately carried around to the distal extremity; in other cases, though a proximal ligature may serve to check the hemorrhage for a short time, as soon as the collateral circulation is fully established, bleeding will again begin from the distal end of the vessel. If, as sometimes happens, the distal extremity of the vessel be so retracted and surrounded by the adjoining tissues, that it cannot be found even after long and careful search, the surgeon may plug the wound with a graduated compress, the apex of which is imbued with the solution of the persulphate of iron, and good results may be hoped for from this proceeding; but, whenever it is practicable, the distal as well as the proximal end of the vessel should unquestionably be tied. If a large arterial branch be wounded immediately below its origin, it is safer to regard the injury as one of the main trunk, and apply ligatures immediately above and below the origin of the branch, as well as on the distal side of the wound in the latter;[1] so, on the other hand, if a large branch be given off immediately above or below an arterial wound, it is proper, after tying the injured vessel in the usual way, to apply an additional ligature to the branch. If this should not be done, there would be risk of secondary hemorrhage from deficiency of the internal coagulum, which, as has been mentioned, extends only as far as the nearest anastomosing vessel.

There are, it is true, a certain number of cases on record, in which the proximal ligature alone, or even the ligature of the main trunk at a distance from the wound, has arrested hemorrhage, which has not recurred; but such cases are quite exceptional, and in no degree invalidate the force of this and the preceding rule of treatment, which might well be called *golden* rules.

4. However desirable it may be to tie a bleeding vessel in the wound, in certain situations it is impossible to do so; thus, in the case of wounds which penetrate the floor of the mouth, dividing branches of the external carotid, or in cases of hemorrhage into the mouth from the internal carotid, or within the pelvis from branches of the internal iliac, it is manifestly impossible to

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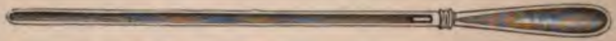
[1] Dr. T. B. Wilkerson, of North Carolina, has recently reported a case in which this plan was successfully carried out in a case of wound of the profunda femoris just below its origin.

reach the seat of the wound, and the surgeon's only resource is to tie the main trunk. Again, in cases of secondary hemorrhage from wounds of the palmar arches, it may be necessary to deviate from the ordinary rule, and tie either the brachial, or the radial and ulnar arteries.[1]

Application of Ligatures in the Continuity of Arteries.—In applying a ligature in the continuity of an artery, whether at the seat of wound or at a higher point, or in the Hunterian operation for aneurism, the surgeon is guided in making his incisions by the lines which he knows to correspond with the general course of the vessel. If there be a wound, that should, of course, be the starting-point for the incision, but in other cases the operator must rely upon the pulsation of the vessel if that can be felt, and if not, upon his general anatomical knowledge as to the course of the artery. It is well, especially when the artery lies deeply, to make the incision, as recommended by Hargrave and Skey, somewhat obliquely to the course of the vessel, which can thus be more readily found than if the incision were directly in its line. The skin and superficial fascia may be divided by the first stroke of the knife, but afterwards the surgeon should proceed with great caution, taking up each successive layer of tissue with delicate forceps, and making a slight notch for the introduction of a grooved director (Fig. 84), upon which the layer is then carefully divided from below upwards. When the sheath of the vessel is reached, the surgeon picks it up in the same way with forceps (Fig. 85, A), and makes an opening just sufficient to allow the passage of the needle which bears the ligature. This is then delicately introduced between the artery and the vein, and very cautiously brought around the former so as to include nothing except the vessel itself. The point of the needle, which must be well ground down and rounded, is then *teazed* through the opening in the sheath (Fig. 85, B), a process which may be facilitated by a gentle touch with the knife, one end of the ligature drawn out, and the other drawn backwards with the needle, which must be withdrawn as gently as it was introduced. The operation is completed by tying the artery firmly and tightly with the reef-knot (Fig. 85, C), and bringing both ends of the ligature out of the wound, which is closed with sutures and lightly dressed.

FIG. 84.



Grooved director.

If any small arterial branch should be cut during the operation, it should be twisted or tied, taking care to secure both ends; the chief precautions to be observed in passing the needle are not to wound the vein, and not to include the latter or any portion of it, or a nerve, in the noose of the ligature. Entanglement of the vein would be very apt to cause phlebitis or gangrene, while ligature of the nerve would at least give unnecessary pain, and might possibly expose the patient to the risk of tetanus. It would likewise cause paralysis of the parts below, which in some situations might be productive of very grave consequences. If, in passing the needle, there should be a gush of blood, more in quantity than could be accounted for by the separation of the sheath, making it probable that the vein had been punctured, the surgeon should either suspend the operation and apply pressure, or should extend his incision and reapply the ligature at a higher point. To allow a ligature to remain which passed partially through a vein, would be equivalent to forming a seton through that vessel, and would certainly expose the patient to the risks of phlebitis, thrombosis, gangrene, and, possibly embolism and secondary pyæmia. It is almost needless to say that the surgeon should be careful not to miss the artery, and tie instead a nerve or even a portion of condensed fascia, an accident which has occasionally happened in the hands of the most skilful operators. If the artery be very superficial, the surgeon should be correspondingly careful not to go too deeply in his first incision, which some operators, indeed, prefer to make by pinching up a fold of skin, transfixing, and cutting from within outwards. In dividing the deeper structures, the side of the knife should be used rather than the point, and the edge should always be directed away from the artery.

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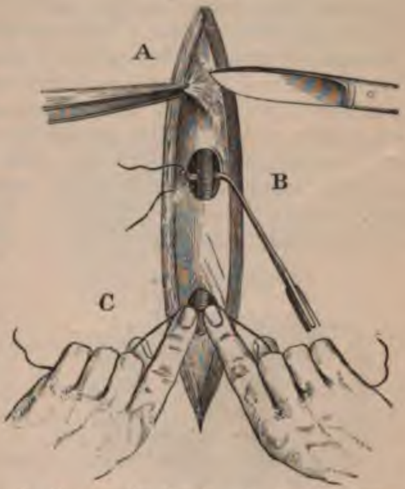
[1] Ogston, of Aberdeen, has successfully tied the deep palmar arch by separating the abductor indicis from the radial side of the metacarpal bone of the index finger, through a dorsal incision.

After tying an artery in its continuity, the limb below should be kept warm until the collateral circulation is fully established; the ligature will usually drop between the first and third weeks, according to the size of the vessel; should it remain too long, gentle traction and twisting may be practised, as in the case of ordinary ligatures on the cut ends of vessels.

FIG. 85.

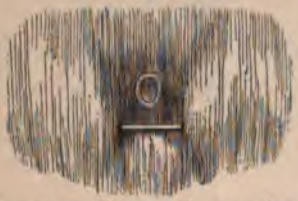


A. Opening the sheath. B. Drawing ligature round the artery. C. Tying artery. (BRYANT.)

8. **Acupressure.**—Acupressure, or the means of controlling arterial hemorrhage by pressure with a needle or pin, was first introduced to the notice of the profession by Sir J. Y. Simpson, in December, 1859. It has since then been employed more or less extensively by a great number of surgeons, and, after having been alternately extolled and condemned, and having excited in the city of its birth one of the most virulent professional controversies of modern times, has now gradually assumed its proper place as one of the modes, and, under certain circumstances, one of the best modes by which arterial bleeding can be arrested. Acupressure may be practised in several different ways, of which Prof. Pirrie and Dr. Keith, who have published a monograph on the subject, enumerate seven; though for practical purposes the number might be reduced to four. In the first two of Pirrie's and Keith's methods, the vessel is compressed between a pin or needle and the soft tissues of the part; in the third, fourth, and sixth, between a pin or needle and a loop of fine flexible wire; in the fifth (or Aberdeen method), the pressure is made by passing a pin or needle beneath the artery, which is then twisted upon itself by a quarter or half rotation of the pin; and in the seventh, the vessel is compressed between the pin and any bony prominence which may be conveniently situated. The *first* method is thus described by Simpson: "It consists in passing a long needle twice through the flaps or sides of a wound, so as to cross over and compress the mouth of the bleeding artery or its tube, just in the same way as in fastening a flower in the lapel of our coat,

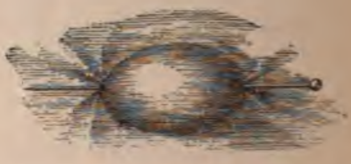
we cross over and compress the stalk of it with the pin which fixes it, and with this view pass the pin twice through the lapel. . . . . When passing the needle in this method, the surgeon usually places the point of his left forefinger or of his thumb upon the mouth of the bleeding vessel, and with his right hand he introduces the needle from the cutaneous surface, and passes it right through the whole thickness of the flap till its point projects for a couple of lines or so from the surface of the wound, a little to the right side of the tube of the vessel. Then, by forcibly inclining the head of the needle towards his right, he brings the projecting portion of its point firmly down upon the site of the vessel, and after seeing that it thus quite shuts the artery, he makes it re-enter the flap as near as possible to the left side of the vessel, and pushes on the needle through the flesh till its point comes out again at the cutaneous surface. In this mode we use the cutaneous walls and component substance of the flap as a resisting medium, against which we compress and close the arterial tube." The exact mechanism of the *first* method can be readily understood from the accompanying wood-cuts (Figs. 86, 87).

FIG. 86.



Acupressure; first method; raw surface. (ERICHSEN.)

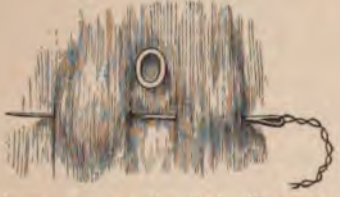
FIG. 87.



Acupressure; first method; cutaneous surface. (ERICHSEN.)

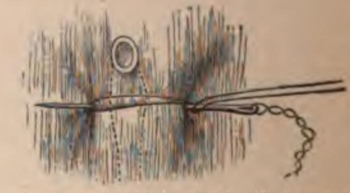
In the *second* method, "a common short sewing-needle, threaded with a short piece of iron wire, for the purpose of afterwards retracting and removing it, is dipped down into the soft textures a little to one side of the vessel, then raised up and bridged over the artery, and then finally dipped down again and thrust into the soft tissues on the other side of the vessel" (Fig. 88). In the *third* method (Fig. 89), "the point of the needle is entered a few lines to one side of the vessel, then passed under or below it, and afterwards pushed on, so that the point again emerges a few lines beyond the vessel. The noose or duplicature of wire is next thrown over the point of the needle; then, after being carried across the mouth or site of the vessel, and passed around the eye end of the needle, it is pulled sufficiently tight to close the vessel; and lastly, it is fixed by making it turn by a half twist or twist around the stem of the needle." The *fourth* method is identical with the third, except that a long pin is substituted for the needle, the head of the pin remaining outside of the wound, while the *sixth* differs from the fourth merely in the way of

FIG. 88.



Acupressure; second method. (ERICHSEN.)

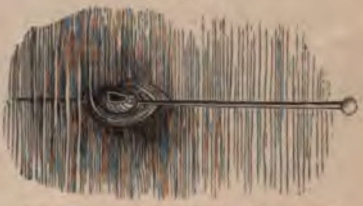
FIG. 89.



Acupressure; third method. (ERICHSEN.)

fixing the wire, the ends of which are, in this method, "crossed behind the stem of the pin so as to embrace the bleeding mouth between them, . . pulled sufficiently tight to arrest the hemorrhage, thereafter brought forward by the sides of the pin—one on each side—and finally fixed by a half twist in front of and close down upon the pin" (Pirrie and Keith, *Acupressure*, p. 44). The *fifth*, or "Aberdeen method," consists in passing a pin or needle through the soft tissues close to the artery, giving the instrument a quarter or a half rotation, by which the vessel is twisted upon itself, and then fixing the pin or needle by thrusting its point deeply into the tissues beyond (Fig. 90). This method seems to me the best and most generally applicable; additional security may be given by superadding the use of a wire loop, as in the preceding methods. The *seventh* and last method consists, according to Prof. Pirrie, "in passing a long needle through the cutaneous surface, pretty deep into the soft parts, at some distance from the vessel to be acupressed—making it emerge near the vessel—bridging over and compressing the artery, dipping the needle into the soft parts on the opposite side of the vessel, and bringing out the point of the needle a second time through the common integument. In this method the soft parts are twice transfixed, and the artery is compressed between the bone and the middle portion of the needle in front of the integument, between the first point of exit and the second point of entrance."

FIG. 90.



Acupressure; fifth method. (ERICHSEN.)

Mode of Repair of Arteries after Acupressure.—This subject has recently been investigated by several writers, the results of whose observations may be stated as follows: There is no direct adhesion of the apposed walls of the vessel, as believed by Dr. Hewson and others, but, on the contrary, the sole process of permanent repair takes place at the cut end of the vessel; the end subserved by the needle is merely to remove the pressure of the blood current until this repair is accomplished. If, however, the needle be allowed to remain so long as to destroy the structure of the lining membrane of the vessel, then closure takes place at the line of this destruction, just as after the use of a ligature. The actual repair which goes on at the cut end of the vessel is due partly to changes in the walls of the vessel itself, and partly to changes in the contained blood, in fact to the same changes which we have already studied as taking place in the process of natural hæmostasis. A clot forms above the needle, and rests upon without adhering to the contracted portion of the artery below. The time during which the acupressure needle should be allowed to remain varies from twenty-four to sixty hours, according to the size of the vessel. If it be removed before the repair of the cut end of the vessel is complete, there will be risk of dislodgement of the clot (which is not adherent), and of hemorrhage; while if it remain too long, it will excite suppuration in its track, just as any other foreign body.

Modified Acupressure.—Under the name of "artery compressor," Mr. Porter, of Dublin, has described an apparatus for the temporary occlusion of an artery in cases of aneurism. It somewhat resembles Sir P. Crampton's "*presse artère*," and consists essentially of a bent probe and a wire, between which the vessel is compressed, and which are so arranged as to be withdrawn at will. Dr. L'Estrange's apparatus for the same purpose consists of a double aneurismal needle, the blades of which close like the jaws of a lithotrite. Instruments of various kinds for the temporary occlusion of arteries have likewise been devised by Deschamps, Desault, Assalini, Durest, Richardson, of Dublin, and others.

Filopressure, or compression of a vessel by means of a wire, has been practised by various surgeons, among whom may be specially mentioned Mr. Dix, Dr. Pollock, and Prof. Langenbeck, and has been described as a modification of acupressure. It is, however, as shown by Simpson, an old mode of treatment, and, I may add, appears to be inferior to both acupressure and the ligature. It is practised by surrounding a vessel with a loop of wire, the ends of which are brought out separately through the flap or side of the wound, and twisted over a compress which serves to protect the skin.

Uncipressure, or compression by means of a hook, is recommended by Vanzetti, of Padua, in cases of secondary hemorrhage from wounds of the palmar arch, etc.

Aërteriversion is a name employed by Prof. Weber, of Cleveland, Ohio, for a mode of arresting hemorrhage suggested by himself, which consists in everting the cut end of an artery so as to invaginate the vessel within its own extremity, and then fixing the parts by the introduction of a needle point or delicate metallic peg.

Comparison between Acupressure, Torsion, and Ligature.—From what has been said with regard to the mechanism by which each of these methods acts, and the pathological changes to which each gives rise, it will appear, I think, that the ligature is to be preferred, whenever the circumstances of the case allow the surgeon to choose between them. The objections urged against the ligature are, that (1) it acts as a seton, causing suppuration along its track; (2) it confines a minute slough in the wound until it comes away itself; and (3) it may become prematurely detached and allow secondary hemorrhage. These objections, though theoretically just, seem to me to be practically of little or no value, for (1) healing without any suppuration is almost never met with (at least in this climate), in wounds of the size of those in which ligatures are used, and no trustworthy evidence has yet been adduced to show that the use of ligatures increases the amount of suppuration; (2) the size of the slough embraced by the noose of the ligature, in cases that do well, is so minute as to be really not worth notice, and in cases where there is extensive sloughing, there is no reason to attribute that sloughing to the use of ligatures; and (3) though hemorrhage may occur upon the detachment of a ligature, it is (unless violence have been used in removing the ligature) due to a defect in the natural process of hæmostasis, which, as we shall presently see, is quite as likely to occur with either torsion or acupressure as with the ligature. Torsion closes arteries just as the ligature does, and there is the same risk of hemorrhage on the separation of the twisted extremity, if it has been twisted enough to impair its vitality, as on detachment of the ligature; while if it have been insufficiently twisted, there is the additional risk of the extremity of the vessel becoming untwisted, and thus allowing bleeding at an earlier period; if, on the other hand, the end be twisted off, the vessel is in the same condition as if it had been tied, and the ligature immediately removed. If the acupressure pin be removed before it produces suppuration, the sole protection against hemorrhage is an incomplete union at the cut end of the vessel, and an unadherent clot above the point of constriction; if it be allowed to remain long enough to cause inflammatory changes in the arterial coats at the point of constriction, it defeats its own object, and acts as a ligature which has been tied and subsequently removed. That both acupressure and torsion are able to control hemorrhage from even large arteries is abundantly proved; that either does so any better than the ligature is, it seems to me, not proved;

while to give the same security that is afforded by the ligature, either must be pushed so far as to be open to the identical objection which is urged against the ligature, viz., that of introducing a foreign body into the wound, and, by so doing, impeding union by adhesion.

I am not aware of any sufficiently extended statistics of torsion having yet been published, to warrant a numerical comparison of the results of this method, with those of the ligature. The reports of Messrs. Syme, Humphry, Bryant, Forster, and Hill, have certainly been favorable, yet the experience of other surgeons who are equally eminent has been opposed to the general employment of torsion; and it is to be observed that Mr. Syme only recommended it in connection with the antiseptic method of Prof. Lister, while the whole number of cases in which it has been used in the human subject is as yet comparatively limited. As regards the statistics of acupressure, the most favorable series of cases yet published is that of Prof. Pirrie and Dr. Keith, and yet even this, when analyzed, shows at least no better results than are obtained by the use of the ligature. Thus, twelve amputations reported by Prof. Pirrie gave three deaths, and yet in all but one case the operation was done for disease, and eight of the twelve patients were children. The theoretical assumption that acupressure guards against the common causes of death after operation, is not borne out by fact—erysipelas, sloughing, and pyæmia having occurred even in the very favorable experience of Messrs. Pirrie and Keith; while union by adhesion, except in Aberdeen, has been quite as rare with acupressure as with the ligature, and even in the few Aberdeen cases in which it is stated that not a single drop of pus was seen during the cure, it does not appear that the period of convalescence was any shorter than it is constantly found to be, when ligatures are used.

What, then, are the real advantages of acupressure? Simply and solely, I believe, that it is more easily and quickly applied than the ligature, and that in its use the surgeon needs no assistant: hence, in cases of emergency, especially of secondary hemorrhage, it is often the surgeon's most available resource, and as such its modes of employment should be familiar to every practitioner. Torsion, on the other hand, is confessed even by its advocates to be a more tedious and difficult proceeding than the application of a ligature, and, therefore, seems to me, although possibly safer than acupressure, even less desirable for general use.

Collateral Circulation.—In whatever way an arterial trunk be occluded, whether by disease or by surgical interference, the vitality of the parts below would be impaired but for the establishment of the *collateral circulation.* The immediate effect of a ligature, or other means of arterial occlusion, is to throw the force of the circulation into new channels, and hence, though the limb below the site of ligature is for a time less full of blood, the balance is soon restored, and after a few hours the activity of the capillary circulation is so much increased, that the part is not unfrequently both redder and warmer than in its natural state. The action of the capillaries is, however, but temporary, the true collateral circulation being established through the inosculation of anastomosing branches, derived sometimes from the affected vessel itself, but more frequently from neighboring trunks on the same side of the body. Thus, if the superficial femoral be tied, the collateral circulation is established through the branches of the profunda, while after ligature of the common carotid, it is principally through the inferior thyroid and vertebral arteries that the circulation is maintained. Even after occlusion of the abdominal aorta, the collateral circulation is established in quite a short time, pulsation in the femoral artery having returned in less than ten hours, in the case of ligature of the aorta, reported by Mr.

Stokes. In old persons, or in those whose arterial system is affected by atheromatous or fatty degeneration, the collateral circulation is less readily established and less perfectly maintained than in the young and healthy, the reason of this obviously being that the arteries of the latter are more elastic, and dilate with greater facility to accommodate the increased flow of blood through them. On the other hand, in cases of chronic aneurism, the obstruction has sometimes gradually caused the establishment of the collateral circulation before ligation is practised, so that under these circumstances surgical interference may be even less resented than when employed for wounds of healthy arteries. This statement would appear to be contradicted by the well-known fact that gangrene is more frequent after ligature for aneurism than after that for traumatic causes, but, as will be seen hereafter, the gangrene in the former case is usually from venous, not from arterial obstruction.

Not only does anastomosis take place between collateral branches, but an indirect communication is sometimes re-established between the divided ends of the obliterated trunk. Finally the fibrous cord, which connects the divided extremities of the artery, occasionally becomes itself pervious, allowing a narrow but direct channel of communication between the proximal and distal ends of the vessel.

The establishment of the collateral circulation is sometimes attended with pain, apparently from pressure of the enlarging vessels upon contiguous nerves; this is most marked in cases of aneurism, in which additional pressure is caused by the coagulation of the blood contained in the sac.

Secondary Hemorrhage.—The most frequent accident after the use of the ligature or other artificial means of arterial occlusion, is unquestionably *secondary hemorrhage*. This may arise from a variety of causes, some of which are local and some constitutional. Among the *local* causes may be mentioned, (1) imperfect application of the occluding means; as when the vessel has been tied so near its cut extremity that the noose slips off prematurely, when the knot has been carelessly made, when a large amount of extraneous tissue has been included in the noose of the ligature, so that this becomes loosened before the vessel is healed, or (which is especially apt to happen with acupressure) when the vessel has been compressed only enough to check bleeding while the force of the heart is diminished by shock or by the use of an anæsthetic, but not enough to occlude the artery when reaction has occurred; (2) the giving off of a large collateral branch either immediately above or immediately below the point of occlusion, a circumstance which, though not necessarily a cause of secondary hemorrhage, is very apt to be so, from limiting the extent of the internal coagulum in the proximal, and more especially in the distal end of the vessel; and (3) a diseased condition of the coats of the artery itself; this may cause hemorrhage *directly*, either by allowing the ligature to ulcerate through the vessel prematurely, or by allowing rupture to take place above the site of the ligature, or more rarely *indirectly*, by giving rise to the formation, above the ligature, of an aneurism which subsequently bursts and permits the escape of blood. In other cases secondary, or rather consecutive, hemorrhage may occur from vessels which escape the notice of the surgeon during an operation, or (in case of ligation in the continuity) from small anastomosing branches, which, though wounded, do not begin to bleed until enlarged by the establishment of the collateral circulation. The *constitutional* causes of secondary hemorrhage may be said to be any conditions of system which interfere with the natural processes which we have seen to be essential for the closure of wounded arteries. Thus, a want of coagulability in the blood itself, the "hemorrhagic diathesis," visceral disease (especially of the liver), an unusually severe attack of ordinary traumatic or inflammatory fever, certain affections which are apt to occur after operations, especially erysipelas, pyæmia, hospital gangrene, or even ordinary sloughing, may all be considered as causes of secondary hemorrhage. In the case of pyæmia, the hemorrhage often consists of capillary oozing—the *parenchymatous hemorrhage* of Stromeyer and Lidell—and is apparently due to mechanical obstruction, from thrombosis of the venous trunks of the part. J. H. Porter has described an *intermittent* form of hemorrhage, which he thinks is due to malarial influence.

Occasionally a single secondary hemorrhage may prove fatal, but more usually there are a number of successive gushes, of which the first may be comparatively slight, the patient being gradually reduced to a state of extreme anæmia, and dying rather from repeated losses of blood, than from the quantity lost at any one time. When hemorrhage occurs after ligature of an artery in its continuity, it is almost invariably from the *distal* extremity of the vessel. The reasons for this appear to be (1) that, as already remarked, the distal clot is smaller and less firm than the proximal, and (2) that, from the constriction of the ligature interfering more with its vasa vasorum, the distal end of the vessel is more exposed to sloughing than the proximal.

Secondary hemorrhage may occur at any time after the application of a ligature, though it is most common about the period of separation of the latter; when it occurs earlier, it is usually owing to some defect in the mode of occlusion, to disease of the arterial tunics, or to some of the systemic conditions which have been referred to. Secondary hemorrhage is occasionally met with, weeks or months after the separation of the ligature; in these cases it is usually due to the occurrence of sloughing, or to the dissolution and reabsorption, under the influence of constitutional causes, of the coagulum and inflammatory adhesions by which closure of the vessel was effected.

Treatment of Secondary Hemorrhage.—The *constitutional* treatment of secondary hemorrhage does not differ from that already described as appropriate to the primary affection; the most valuable *medicines*, in this condition, are, I think, opium and ergot, which may be freely administered; special care should be taken to prevent any straining in defecation or violent coughing; quinia should be given if there is any malarial complication. The *local* treatment of secondary hemorrhage varies according as the bleeding proceeds from a *stump*, or from an artery ligated in its *continuity*. It should be premised that the rule not to operate on an artery which has stopped bleeding, does not apply in either of these cases. As Mr. Erichsen puts it, the surgeon in these cases *may* after the first, and *must* after the second bleeding adopt determined measures to prevent a return of the hemorrhage.

1. *Secondary Hemorrhage from a Stump* may, if in only moderate amount, be often checked by the judicious application of pressure, position, and cold. Should, however, these means fail, or should the bleeding be so free as to render it probable that it comes from a large vessel, the proper course to be pursued depends upon the condition of the stump itself; if the process of cicatrization in the latter be not far advanced, or, under any circumstances, if its cavity appear to be stuffed and distended with clots, the surgeon should without hesitation break up the adhesions, and search for the bleeding artery on the face of the stump itself, applying a fresh ligature to whatever vessel is found to be in fault. If, on the other hand, the stump be nearly healed, and do not appear to be stuffed with clots, it is proper to attempt to secure the bleeding vessel, or the artery of which it is a branch, *immediately above the stump:* this may be done by cutting down and applying a ligature, or, preferably, by acupressing the vessel by Simpson's first method; this is one of the exceptional cases in which acupressure seems to be particularly applicable, and there would be every reason to hope, under such circumstances, that

the temporary occlusion of the artery by the pin would be sufficient to allow the completion of the natural process of repair at the cut extremity of the vessel. Ligation of the *main artery* of a limb, for hemorrhage from a stump, is in most situations a bad operation, and should only be resorted to when prolonged search has failed to find the artery in the reopened wound (an event which may occur from the sloughing and disorganized condition of the part), and when the vessel cannot be secured immediately above the stump. The reasons for this are, that in many cases the operation would fail to check the hemorrhage, that it would expose the patient to great risk of gangrene, and that it would superadd an operation, in itself serious, to the dangers which already existed: hence, in some situations, even re-amputation might be a safer and better procedure than ligation of the main trunk. In some positions, however, as after amputation at the shoulder-joint, or high up in the thigh, ligation of the main trunk may be the only resource available, and in such cases the vessels to be secured are the axillary for the upper, and the external iliac for the lower extremity.

2. *Secondary Hemorrhage from an Artery previously Ligated in its Continuity* is an accident of the gravest nature. In its treatment the surgeon may properly first try the effect of pressure, adjusting accurately to the bleeding point a graduated compress, and keeping it in position with a ring tourniquet, or arterial compressor. In the case of some arteries, as the subclavian or iliacs, and generally in the case of vessels situated about the trunk, no other means are applicable, and the use of pressure should then be persevered in, though it must often prove ineffective. In the case of the upper extremity, if pressure fail, the surgeon should treat the vessel as one primarily wounded, cutting down and tying the vessel above and below the source of hemorrhage; if hemorrhage again recur, or if the bleeding vessel cannot be found or secured in the wound, a ligature may be applied with fair hope of success to the main artery at a higher point. Should this fail, amputation at the highest point of ligature should be resorted to. In the lower extremity, the case is somewhat different. If the bleeding be from the femoral artery, an attempt may be made to apply fresh ligatures in the wound, above and below the source of hemorrhage, and this course will occasionally succeed, as in a case under my care at the University Hospital; though, as shown by Mr. Cripps's statistics, carefully applied pressure is often the most promising remedy in these cases. The tibial vessels lie so deeply that it would be almost hopeless to attempt a second ligation in case of secondary hemorrhage after tying one of them, though it might perhaps be tried, if the condition of the patient warranted the effort. Ligation of the main trunk under these circumstances *in the lower extremity* would almost inevitably cause gangrene, and should not be attempted. Amputation at or above the site of ligature would be a safer operation, and should, I think, in this situation, undoubtedly be preferred.

Gangrene after Arterial Occlusion, whether from disease or from surgical interference, is due to a deficiency in the collateral circulation; it is most often met with in the lower extremity, and in those whose arteries from age or other cause are in an inelastic condition, whether accompanied or not by positive degeneration. Among the exciting causes may be mentioned loss of blood (as from secondary hemorrhage), venous congestion (hence it is more frequent after ligations for aneurism than after those for wounds), erysipelas, the application of cold or of excessive heat, or the use of even moderately tight bandages. It is usually manifested from the third to the tenth day, and is commonly, on account of venous implication, of the moist variety; occasionally, however, it assumes the character of dry gangrene or mummification. These conditions have been already described, in discussing the subjects of inflammation and of mortification as a cause for amputation, and need not therefore be again referred to. Much may be done to prevent the occurrence of gangrene after ligation of an artery, by wrapping the limb in cotton-wool, so as to keep up its temperature and protect it from external injury, and by placing hot bottles or hot bricks under the bedclothes, though not in contact with the limb. Should there be much venous congestion, gentle but methodical friction from below upwards might be practised, so as to assist in emptying the superficial veins. Should gangrene actually occur, amputation must be practised through the site of arterial occlusion, unless when, after injury of the femoral artery, the gangrene is limited to the foot, when, as pointed out by Guthrie, amputation below the knee will usually be sufficient. (See page 92.)

Remote Consequences of Arterial Occlusion.—Even when everything goes well after the ligation of a main artery, the limb is sometimes left for a long while numb and weak. In the case of the lower extremity, it is often œdematous, and apt to become inflamed from apparently slight causes. In such cases the limb should be warmly clad, and supported with an elastic bandage, while care should be taken to avoid undue pressure, which might give rise to ulceration, or even gangrene.

Traumatic Aneurism.—Under this name are included several distinct affections:

1. The *Diffused Traumatic Aneurism* (so called), is, as Prof. Gross justly remarks, no aneurism at all, but merely a collection of arterial blood in the tissues of a part, differing from an ordinary case of wounded artery simply by there being no communication with the external air. This condition of affairs may result either from an originally subcutaneous lesion of an artery, or from the external wound healing before the arterial aperture itself is closed. It not unfrequently is a consequence of gunshot injury, the arterial wall being bruised though not severed by the contact of the ball, and giving way after an interval of perhaps several weeks, during which the external wound may have completely healed. The diagnosis of this condition can usually be made with tolerable facility; there is an oblong, somewhat pyriform swelling, more or less elastic and fluctuating, and, if the arterial wound be tolerably free, accompanied by a distinct impulse, and often by a marked thrill and aneurismal bruit. The limb below is œdematous, and the pulse very feeble or completely absent. As the disease advances, the skin covering the tumor becomes tense, thin, and discolored, and unless efficient treatment be adopted, the limb may become gangrenous, though more commonly the tumor will suppurate and open externally, allowing profuse secondary hemorrhage to occur. The *treatment* is the same as for an ordinary case of wounded artery. The circulation being temporarily controlled by pressure applied as already directed, the surgeon lays open the tumor, turns out the clots, and applies ligatures to both ends of the affected vessel; this is most conveniently done by introducing a director into the mouth of the artery, dissecting it up for about an inch, and passing a ligature around it with an ordinary aneurismal needle. If the arterial wound be in such a situation that effective pressure cannot be made above it during the operation, the surgeon must proceed more cautiously, in the way recommended by Prof. Syme; in this case the incision should be at first merely large enough to admit one or two fingers of the left hand, which may plug the wound as they are introduced, and thus prevent hemorrhage, until, guided by feeling the current of warm arterial blood, they reach the aperture in the vessel; having thus control of the bleeding orifice, the surgeon may now enlarge his incision, turn out the clots, and still keeping up pressure with

the left hand, endeavor to pass a ligature with the right; in doing this, a mounted needle, eyed at the point (Fig. 68), or a short curved needle, held with suitable forceps, may prove of more service than the ordinary aneurismal needle. In some instances, especially in military practice, the safety of the patient will be more promoted by amputation, than by any attempt to secure the vessel by ligation; particularly is this the case when the brachial artery is wounded near its origin, the aneurismal tumor encroaching upon the axilla; under such circumstances I believe amputation at the shoulder-joint to be often the best mode of treatment.

2. There is another form of traumatic aneurism, of which the pathology is the same as of that which has been described, but in which the extravasation is less extensive, and in which an adventitious sac has been formed by the condensation of the surrounding areolar tissue. This, which is, clinically speaking, a *Circumscribed Traumatic Aneurism*, commonly results from punctured wounds, and is rarely met with except in the course of the smaller arteries; it may be treated by laying open the sac and tying the vessel above and below; or, if in a position where this operation would be undesirable, as in the palm of the hand, the main trunk may be ligated with the prospect of a favorable result. When met with in connection with a large artery, a proximal ligature may be applied as close as possible to the sac, without opening the latter.

3. Another form of circumscribed traumatic aneurism is that which has been called "*Hernial*," and which results from the protrusion of the inner coats of the vessel through a wound or laceration of the outer tunic. This form of aneurism is extremely rare, its existence indeed being doubted by many writers.

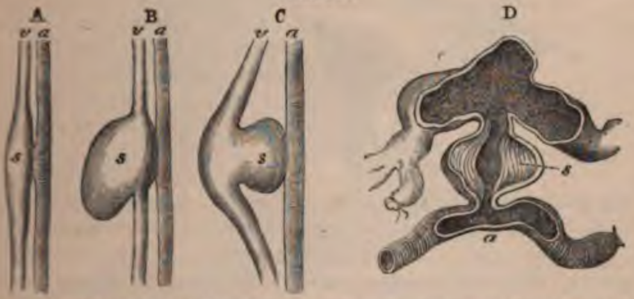
4. The *True Circumscribed Traumatic Aneurism* results from a punctured wound of an artery (generally a large one), which has healed, the cicatrix afterwards yielding, and a true sac being thus formed from the external coat of the vessel and its sheath. The treatment consists in compression or in ligation of the artery at as short a distance as possible above the sac. Should, however (in any of these forms of circumscribed traumatic aneurism), the sac burst, allowing the aneurism to become diffused, or should suppuration or gangrene appear imminent, the proper course would be to lay open the part freely, and apply ligatures above and below, as in the case of the so-called diffused traumatic aneurism already described.

Arterio-venous Wounds.—Occasionally an artery and its contiguous vein are simultaneously wounded, the external wound healing, but a communication remaining between the two vessels. This accident most frequently follows upon punctures, as of the brachial artery in bleeding, though it may also result from a gunshot wound, as in a case to which I have already referred. The preternatural communication between an artery and vein may assume two distinct forms, known respectively as *aneurismal varix* and *varicose aneurism*.

Aneurismal Varix consists in a direct communication between an artery and a vein, part of the arterial blood finding its way into the vein, which is dilated and somewhat tortuous; the symptoms are the presence of a small, somewhat oblong, compressible tumor, with a jarring sensation communicated to the hand, and a buzzing or rasping sound, rather than the ordinary aneurismal whirr. The sound is more distinct above than below the tumor, and the limb is usually somewhat weaker and colder than natural. The condition is not progressive, and requires, as a rule, no treatment beyond the support of an elastic bandage: should anything further be needed, the artery must be tied above and below its aperture.

Varicose Aneurism.—In this form of arterio-venous aneurism, there is a distinct sac, which communicates also with a vein, which is itself always varicose. It differs from an aneurismal varix, in that the arterio-venous communication is indirect, through an interposed aneurismal sac. Its symptoms are a combination of those of aneurismal varix and of ordinary traumatic aneurism: the tumor gradually enlarges, and becomes more solid from the deposition of fibrin, there is a distinct impulse added to the jarring sensation of the aneurismal varix, and there is an aneurismal whirr superadded to the rasping sound heard in the former affection. The sac in this form of disease has two openings, one into the artery and one into the vein, and thereby is much in the condition of the sac of a traumatic aneurism which has become diffuse by rupture; hence the proper treatment consists in laying open the tumor and tying the artery above and below; in doing this, it must be borne in mind that the first incision (which opens the dilated vein) merely exposes the external orifice of the sac, and that this must be laid open by a *second* incision, when the aperture of the artery will be found more deeply seated. Annandale advises that both artery and vein should be secured with double ligatures, and reports a case of traumatic popliteal arterio-venous aneurism successfully treated in this way. A similar case in the hands of Dr. Keyes, of New York, terminated fatally from pyæmia. For the varicose aneurisms met with at the bend of the elbow, Vanzetti recommends simultaneous compression of the brachial artery and the basilic vein. Medini records a case of arterio-venous aneurism of the carotid artery and internal jugular vein, in which a cure was effected by means of direct compression.

FIG. 91.



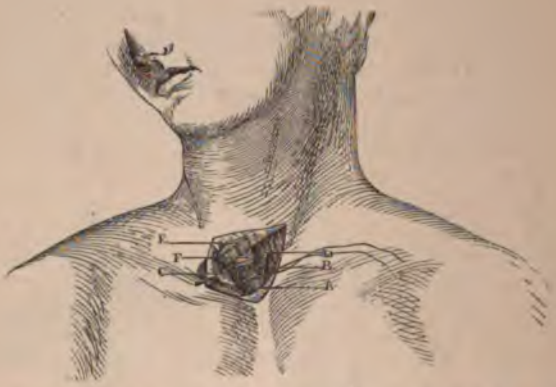
A, aneurismal varix; B, C, and D, varicose aneurisms; *a*, artery; *v*, vein; *s*, sac. (BRYANT.)

LINES OF INCISION FOR DELIGATION OF SPECIAL ARTERIES.

I have gone so fully into the discussion of the principles which should guide the surgeon in the management of arterial hemorrhage, and of the various accidents which follow arterial wounds, that I do not think it necessary or even desirable to recur to the subject in connection with each special artery. I purpose merely, therefore, in this place, to indicate as concisely as possible the lines of incision to be adopted in applying ligatures to the several arteries, whether the operation be required on account of injury or of disease. The *statistics* of the various ligations will be fully considered under the head of Aneurism.

Innominate or Brachio-cephalic Artery.—This vessel may be reached by an incision at least two inches long, corresponding to the anterior edge of the *left* sterno-cleido-mastoid muscle, and extending in the form of an ⌋ across the top of the sternum, and in the line of the right clavicle (Fig. 92). Care must be taken to avoid the thyroid plexus of veins, the middle thyroid artery, and the pneumogastric and phrenic nerves. The needle should be passed behind the artery, from without inwards, so as to avoid the innominate vein which lies on its outer side.

Fig. 92.



Ligation of the innominate artery. A. Innominate. B. Carotid. C. Subclavian. D. Inferior thyroid vein. E. Sterno-mastoid muscle. F. Sterno-hyoid and sterno-thyroid muscle. (Skey.)

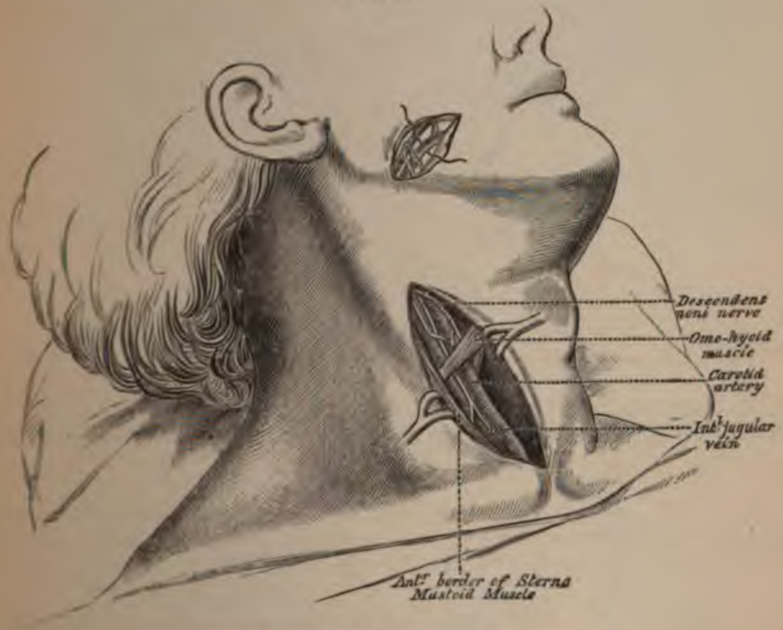
Common Carotid.—This vessel may be tied either above or below the point at which it is crossed by the omo-hyoid muscle (Fig. 93). In either case, the guide to the artery is the inner edge of the sterno-mastoid muscle, the patient's head being thrown backwards, and inclined to the opposite side. The incision for the upper operation (which is the best, when practicable) extends from near the angle of the jaw to a little below the cricoid cartilage; for the lower operation, from a little above the cricoid cartilage, about three inches downwards, along the edge of the sterno-mastoid muscle. The ligature should be passed from without inwards, avoiding the jugular vein and pneumogastric nerve. In opening the sheath, care should be taken to avoid the "descendens noni" nerve, which, however, it is said, has been occasionally divided in this operation, without unpleasant consequences resulting.

External Carotid.—This vessel may be reached by an incision parallel to, but half an inch in front of, the inner edge of the sterno-mastoid muscle, and extending from near the angle of the jaw to a point corresponding to the middle of the thyroid cartilage.

Internal Carotid.—Should it be thought proper in case of a wound of this vessel to attempt its ligation rather than that of the common trunk, an incision may be made as for ligation of the latter in its upper part, the vessel being traced to its bifurcation, and ligatures then applied above and below the bleeding orifice. Dr. W. H. Bramlette, of Virginia, and Dr. W. O. Byrd, of Illinois, have reported cases in which they tied the common carotid and both its branches for gunshot injury.

Vertebral Artery.—This vessel may be reached by an incision corresponding to either the anterior (Maisonneuve) or the posterior border (Smyth) of the sterno-mastoid muscle. The guide to the artery is the transverse process of the sixth cervical vertebra.

FIG. 93.



Ligation of carotid and facial arteries. (BRYANT.)

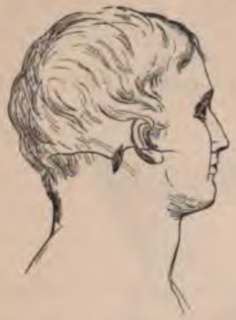
Superior Thyroid.—This vessel may be reached either by an incision across the upper part of the neck, from the side of the hyoid bone obliquely outwards and downwards to the edge of the sterno-mastoid muscle, or by an incision of about two inches along the inner border of the latter muscle.

Lingual Artery.—This may be tied through an incision an inch long, made in a direction downwards and forwards, immediately behind the corner of the hyoid bone (Fig. 96). The superior laryngeal nerve should be carefully avoided in passing the needle. Podraski and Hueter recommend an incision along the upper border of the hyoid bone. The platysma myoides being divided, and the submaxillary gland turned upwards, the artery is found immediately beneath the fibres of the hypoglossus, in the so-called triangle of Lesser.

The **Facial Artery** is most easily secured where it crosses the lower jaw (Fig. 93); the **Occipital,** as it emerges from beneath the splenius muscle, behind the mastoid process of the temporal bone (Fig. 94); and the **Temporal,** immediately above the zygoma (Fig. 95).

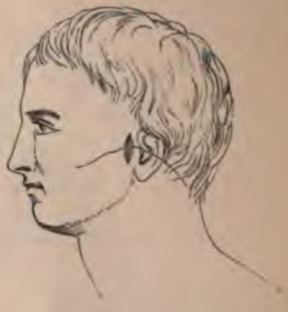
Subclavian Artery.—The *Right Subclavian* may be tied in the first part of its course, that is, between the trachea and the scaleni muscles, by the incision recommended for ligature of the innominate; on the *left* side the vessel is so deeply seated as to render the operation almost impracticable, though if it be attempted, the same incision (reversed) should be employed. This operation has, I believe, been performed but *twice* on the living subject —by J. K. Rodgers, of New York, and by McGill, of Leeds, the latter surgeon's operation being indeed not strictly a ligation, but an attempt to cure a subclavian aneurism by exposing the vessel and temporarily compressing it with torsion forceps. *Either subclavian* may be tied in the *third* part of its course, or exterior to the scaleni muscles, by an incision about three inches long, corresponding to the upper border of the clavicle, the shoulder being

FIG. 94.



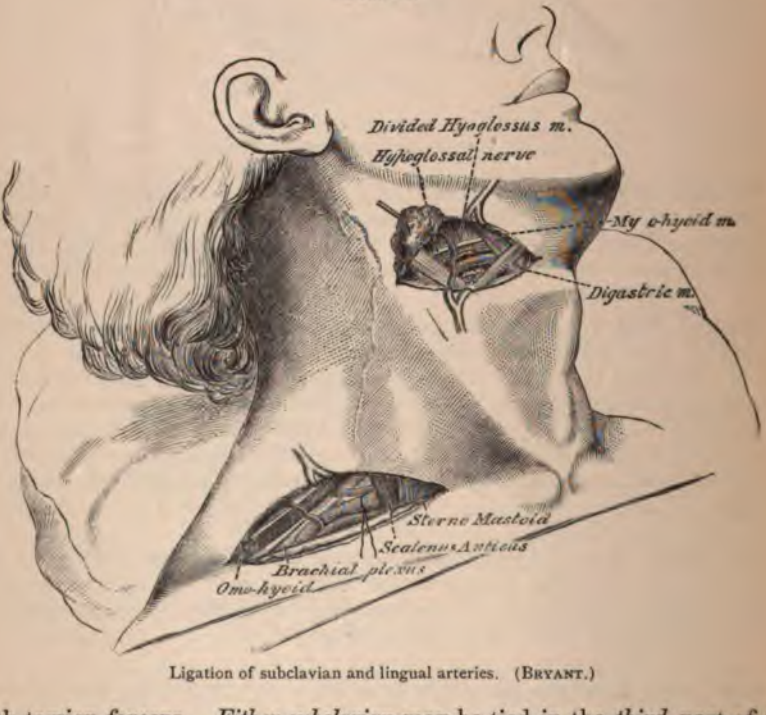
Ligation of the occipital artery. (SKEY.)

FIG. 95.



Ligation of the temporal artery. (SKEY.)

FIG. 96.



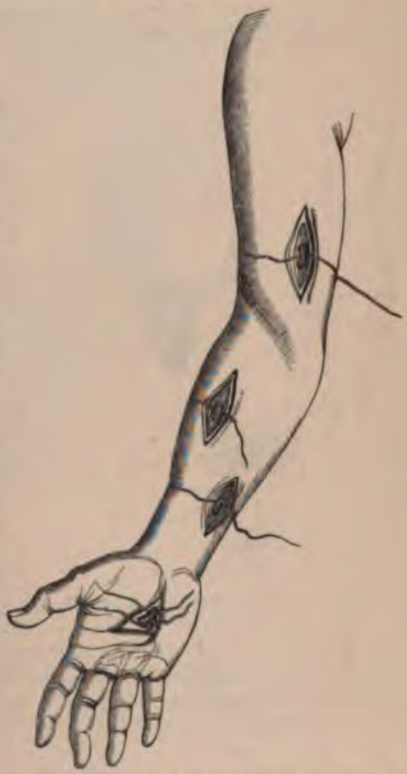
Ligation of subclavian and lingual arteries. (BRYANT.)

drawn down, and the head turned to the opposite side; in dividing the superficial fascia, care must be taken not to wound the external jugular vein. After cutting through, if necessary, some of the fibres of the sterno-mastoid muscle, the surgeon cautiously works his way down to the outer edge of the scalenus muscle, in the angle between which and the first rib, the vessel lies: the needle should be introduced from below upwards. The artery may be tied in the *second* part of its course, by the same incision, the anterior scalenus muscle being cautiously divided upon a grooved director; the parts to be specially guarded from injury in this operation are the phrenic nerve, the jugular vein, the thyroid axis, and the pleura. Mr. Skey recommends for ligature of the subclavian in its outer part, an arched incision, which "is commenced about two and a half or three inches above the clavicle, upon, or immediately on the outer edge of the mastoid muscle, . . . carried slightly outwards and downwards towards the acromion, and then curved inwards along the clavicular origin of the mastoid muscle."

Axillary Artery.—This vessel may be tied either below the clavicle or in the axillary space. For the former operation, an incision either straight or semilunar (in which case it must be convex upwards) is made below the clavicle from near its sternal end to near the attachment of the deltoid muscle. The fibres of the pectoralis major require division, and care must be taken to avoid the cephalic vein and acromial thoracic artery. The needle is passed from below upwards. To secure the artery *in the axilla*, an incision of about three inches is made along the border of the latissimus dorsi muscle, though many surgeons prefer an incision more oblique to the course of the vessel; the ligature may be passed from within outwards, between the roots of the median nerve, which, in this position, lie on either side of the artery.

Brachial Artery.—This vessel may be tied in its upper part by an incision along the inner edge of the coraco-brachialis muscle, or in its middle and lower parts by an incision corresponding to the ulnar edge of the biceps. The artery lies very superficially in its whole extent, and is perhaps more easily tied than any other in the body. The ulnar nerve lies to its inner side, while the median nerve, which above is to the outside of the vessel, crosses in front of it at about its middle. In operating upon the brachial artery, its occasional high division must be borne in mind.

FIG. 97.



Ligation of the brachial, radial, and ulnar arteries; also of the palmar vessels. (MILLER.)

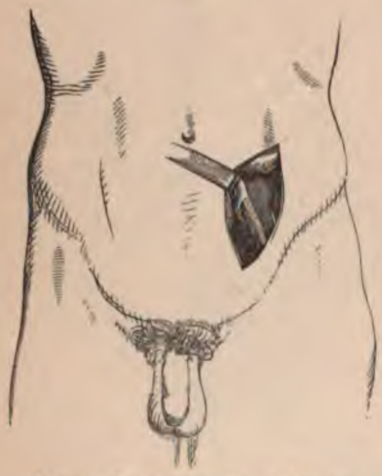
Radial Artery.—This vessel, in its upper part, lies between the supinator longus and pronator teres muscles; and, below, between the former and the flexor carpi radialis. It may be reached in any portion of its course by an oblique incision crossing a line from the middle of the arm, at the bend of the elbow, to the ordinary place of feeling the pulse. The radial artery behind the thumb may be exposed by an incision about an inch long, across the proximal ends of the metacarpal bones of the thumb and forefinger.

Ulnar Artery.—The general course of this vessel may be described by a line drawn from the middle of the bend of the elbow, obliquely inwards, to a point half-way down the forearm, and thence parallel to the ulnar edge of the latter, but an inch to its outside. The radial border of the flexor carpi ulnaris may be considered a guide to the vessel in the middle part of its course.

Interosseus Artery.—This vessel may be reached by an incision similar to that required for ligation of the ulnar in its upper third. The operation has been successfully performed by Michel, of Nancy, but is very seldom required.

Abdominal Aorta.—The aorta may be reached by a curved incision on the left side of the body, convex towards the vertebræ, and extending from the cartilage of the tenth rib to near the anterior superior spinous process of the ilium, the length of the wound being about six inches. The various structures being divided down to the peritoneum, this membrane is cautiously pushed backwards, the surgeon tracing up the common iliac to its bifurcation, about an inch above which the ligature should be applied; the needle is passed around the aorta from left to right, and from behind forwards, special care being taken not to injure the vena cava, which lies to the right, nor the filaments of the sympathetic nerve, which lies in front of the vessel.

FIG. 98.



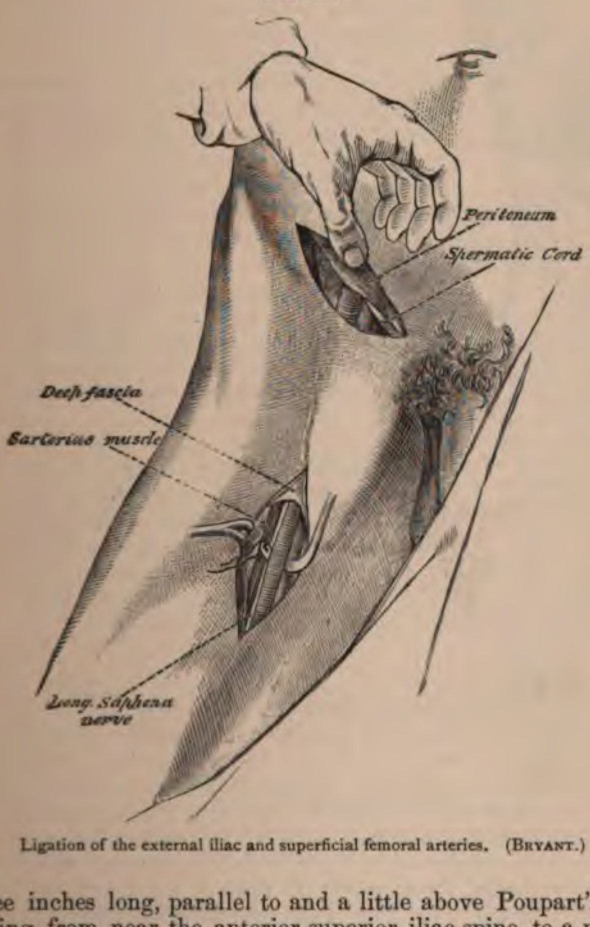
Ligation of the common iliac. (LISTON.)

Common and Internal Iliacs.—Either of these arteries may be reached by a curved incision, five to seven inches long, passing from above the anterior superior spinous process of the ilium, about half an inch above Poupart's ligament, to the external abdominal ring; the peritoneum is carefully stripped upwards, and the needle passed from within outwards, around whichever vessel is to be secured. In tying the *internal iliac*, the surgeon must be specially cautious not to wound the *external iliac vein*, which lies in the angle formed by the bifurcation of the common artery.

Gluteal and Sciatic Arteries.—The former vessel may be reached by an incision in a line from the posterior superior spinous process of the ilium, to a point midway between the tuber ischii and the great trochanter; the latter, by a similar incision, about an inch and a quarter below the position of that already described.

External Iliac.—This vessel may be tied by Liston's modification of Abernethy's method, or by that recommended by Sir Astley Cooper. In the first operation an incision is made from about two inches within the anterior superior spinous process of the ilium, in a curved line, inwards and downwards, to an inch and a half above the middle of Poupart's ligament; the wound, which is convex downwards, should be three or four inches long. All the tissues being carefully divided down to the peritoneum, the latter is cautiously pushed and held out of the way, while the artery is secured by passing the needle from within outwards. Cooper's incision (Fig. 99), is about three inches long, parallel to and a little above Poupart's ligament, and reaching from near the anterior superior iliac spine, to a point above the inner border of the abdominal ring. The external oblique tendon being divided, the spermatic cord appears, and beneath it the artery may readily be found. The disadvantages of this operation are the risks of wounding the epigastric artery and circumflex artery and vein; hence, in most cases, Abernethy's is the best incision, especially as it can very easily be extended upwards, so as to allow the common trunk to be reached, if that should be found necessary.

FIG. 99.

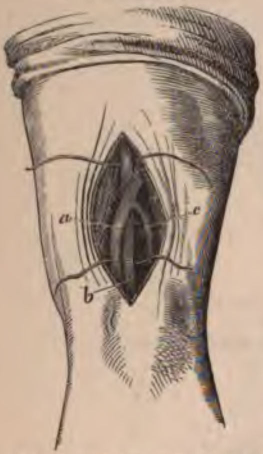


Ligation of the external iliac and superficial femoral arteries. (BRYANT.)

Femoral Artery.—The *Common Femoral* artery can be readily reached by an incision made directly downwards from Poupart's ligament, in the line of pulsation of the vessel; the operation of ligation is, however, not very safe in this situation, and the external iliac is usually tied in preference to the common femoral. The *Superficial Femoral* artery may be tied in any portion of its course, though the operation is best done at the apex of "Scarpa's triangle," where the artery is crossed by the sartorius muscle (Fig. 99); the incision for this operation should be three or four inches long, beginning about two inches below Poupart's ligament, midway between the anterior superior iliac spine and the symphysis, and carried downwards in the axis of the limb, somewhat obliquely to the edge of the sartorius muscle. The femoral vein in this part of its course lies to the inside of the artery, and the needle should, therefore, be passed from within outwards. The femoral artery may also be tied at a lower point, where the sartorius muscle will still be the guide for the surgeon's incision, the vessel, which at first lies inside of this muscle, afterwards crossing beneath it, and finally being external to it.

The *Profunda*, or *Deep Femoral Artery*, may be reached by an incision similar to that employed for the common femoral, the latter vessel being traced down to its bifurcation, and the deep femoral tied about half an inch below the origin of its circumflex branches.

FIG. 100.



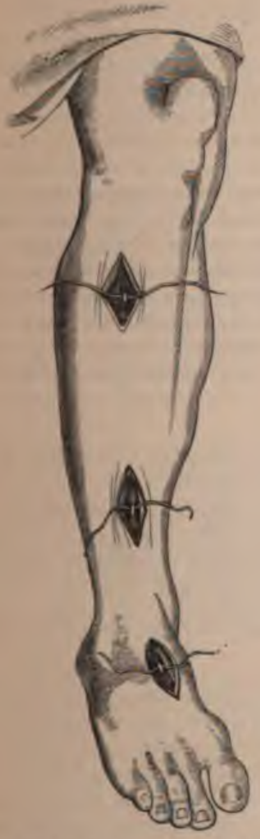
Ligation of the popliteal at its upper and lower parts. *a*. The popliteal vein. *b*. The popliteal artery. *c*. The posterior saphenous vein. The popliteal nerve, on the outside of the artery, has been omitted in the diagram. (MILLER.)

Popliteal Artery.—This vessel may be reached in its *upper* third by an incision along the outer border of the semi-membranosus muscle, and in its *lower* third by an incision between the heads of the gastrocnemius (Fig. 100). The vein in the former situation lies to the outer, and in the latter to the inner side of the artery; in either case the needle should be introduced *between* the two vessels.

Anterior Tibial.—This artery may be found, in its upper third, in the space between the tibialis anticus and extensor communis muscles. The incision is made rather more than an inch outside of the spine of the tibia, and should be about three inches long. In its lower half the artery may be found just outside of the extensor proprius pollicis tendon, which, in this situation, is the guide for the surgeon's incision. Care must, of course, be exercised in passing the ligature, to avoid the venæ comites and the anterior tibial nerve. On the *dorsum of the foot*, this artery may readily be found between the tendons of the extensor pollicis and extensor brevis digitorum. Its course corresponds to the line of the first metatarsal interspace.

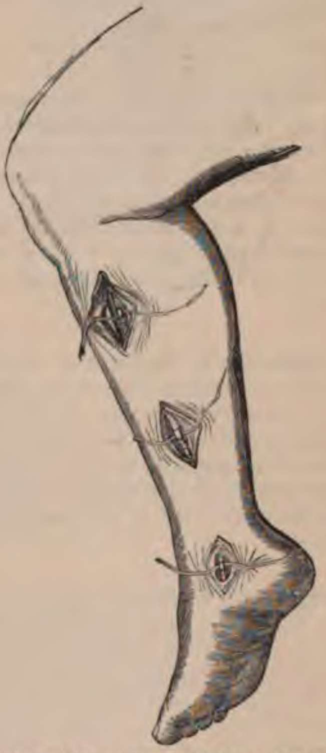
Posterior Tibial.—This artery may be tied in the calf of the leg, or just above the ankle: in the former position, the operation should only be done for hemorrhage, when the wound must be made the guide for the incision, which should be in the direction of the fibres of the gastrocnemius, and about four inches long. Above the ankle, the artery may be easily reached by a semilunar incision, concave forwards, about three-fourths of an inch behind the inner malleolus, and from two to three inches in length; the needle should be passed from behind forwards, so as to avoid the accompanying nerve.

FIG. 101.



Ligation of the anterior tibial at various parts. The wounds are supposed to be held asunder. The ligature is under the vessel. (MILLER.)

FIG. 102.



Ligation of the posterior tibial at various parts. The wounds are supposed to be held asunder. The ligature is under the vessel. (MILLER.)

Peroneal Artery.—If this vessel should require ligation, which can only be in case of wound, an incision must be made similar to that recommended for ligation of the posterior tibial in its upper third, except that in this instance it will, of course, be on the outer or fibular side of the calf. The artery will be found lying in a groove between the fibula, flexor pollicis muscle, and interosseous ligament.

CHAPTER X.

INJURIES OF NERVES, MUSCLES AND TENDONS, LYMPHATICS, BURSÆ, BONES, AND JOINTS.

INJURIES OF NERVES.

Contusions.—Nerves are frequently subjected to *contusion;* the effects of this injury, which is manifested by local pain and a tingling sensation (*pins and needles*, as it is popularly called) along the course of distribution of the nerve fibres, are commonly evanescent, though in persons of a hysterical or nervous disposition they may be more permanent, giving rise, in some instances, to a distressing form of neuralgia; or the neurilemma may become thickened as a consequence of the bruise, causing by pressure a form of partial paralysis, or, more rarely, a secondary morbid condition of the nerve centres.

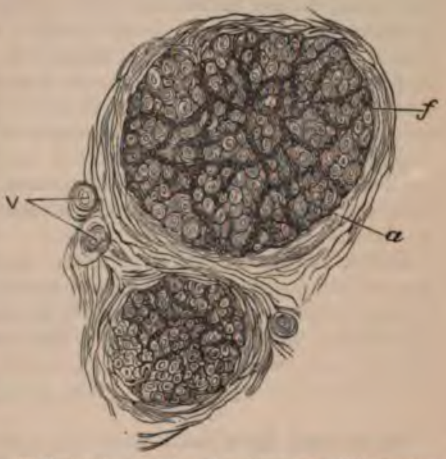
Laceration or Rupture of nerves sometimes occurs as a subcutaneous injury, as in cases of dislocation, when the lesion may be a direct result of the injury, or may be caused by the force used in attempts at reduction. Paralysis sometimes exists in these cases from the first, or may come on several weeks subsequently, and be attended with muscular atrophy; according to Duchenne, sensation is less impaired in these cases than motion. The *treatment* should consist in the use of electricity, douches, and suitable gymnastic exercises.

Punctured Wounds of nerves usually result from the pricks of needles, or of the lancet in venesection. Partial paralysis and neuralgia may result, and may affect not only the parts supplied by the injured nerve, but adjoining parts as well, as in cases recorded by Graves and others. In some instances general convulsions have been observed, and in one case, quoted by Mitchell from Swan, relief was afforded only by making a free incision above the seat of injury.

Complete Division of a nerve causes paralysis of the parts supplied, with a diminution of temperature, and certain nutritive changes which have been studied by Sir James Paget, and more recently and fully by Drs. Mitchell, Morehouse, and Keen, of this city, and by Dr. Middleton Michel, of Charleston, S. C. These nutritive changes may be classified as diminished tension with muscular atrophy and contraction; a peculiar alteration of the skin and its appendages, manifested by a glossy appearance, loss of hair, incurvation of nails, and the occurrence of eczematous eruptions; subacute, rheumatoidal, articular inflammations (*arthropathies*); absence of perspiration from the affected part; the whole accompanied in many cases by a peculiar and very distressing *burning pain*. In some rare instances the temperature of the affected part is absolutely higher than the normal standard.

Repair of Nerves after Division.—The divided ends of a cut nerve are observed to become bulbous, the proximal being invariably larger than the peripheral bulb, and to pass through certain degenerative changes which have been particularly studied by Waller and by Ranvier, and in this country by Dr. R. M. Bertolet, and which are subsequently followed by a process of repair, the nuclei of the neurilemma undergoing proliferation, and the continuity of the trunk being ultimately restored by means of delicate fibres projected from either segment, and by the coalescence of spindle cells in the intermediate cicatricial portion. In some cases neighboring nerves appear to act vicariously for those trunks which are divided, thus presenting a condition somewhat analogous to the collateral circulation in cases of arterial obliteration. If a large portion of a nerve be excised, there is usually no reproduction, and the only chance of restoration of function is in the vicarious action above alluded to. In some cases the extremity of a divided nerve, or even an undivided nerve, becomes involved in the dense tissue of a cicatrix, or in the exuberant callus produced in the repair of a fracture. A very painful neuralgic and paralytic condition may result from this circumstance, requiring surgical interference, which has been successfully applied in such cases by Warren, Ollier, Busch, and others.

FIG. 103.



Wallerian degeneration of median nerve; 180 diameters. (BERTOLET.)

Treatment of Wounded Nerves.—It has been proposed to unite the cut extremities of divided nerves by means of sutures, and numerous cases have been reported in which this has been done with favorable results. There is, however, no reason, according to Mitchell, who has paid particular attention to this subject, to believe that immediate union of a cut nerve can ever be obtained, though the use of a suture might hasten restoration of function. If this plan should be resorted to, the ends of the nerve may be brought together with a delicate wire secured by passing its extremities through a perforated shot or Galli's tube (as was done by Nélaton), or a fine pin or acupressure needle and wire loop may be used as in the hare-lip suture. Bakowiecki recommends sutures of catgut, passed through the neurilemma only. Braun, Langenbeck, Ogston, MacCormac, Holmes, Wheelhouse, Holden, Savory, Hulke, Page, F. L. Parker, Parks, Letiévant, and Esmarch have recorded cases in which nerve-suture was resorted to long after the occurrence of the injury, and, usually, with good results. Gluck has reported several successful experiments in *nerve-grafting* in the lower animals. The pain attending nerve wounds may be alleviated by the application of warmth or cold, according to the feelings of the patient, and especially by the hypodermic use of morphia. Repeated blistering is recommended by Dr. Mitchell and his co-laborers, for the *burning pain* of nerve injuries (*causalgia*)—and for the muscular atrophy, faradization with the electro-magnetic battery, shampooing, and the alternate use of hot and cold douches. In a case of *painful spasmodic contraction* of the forearm, following a gunshot injury, Nüssbaum afforded relief by exposing and forcibly stretching the nerves which supplied the affected part, and similar operations have been since reported by the same surgeon, and by Billroth, Gärtner, Callender, Palmer, Petersen, T. G. Morton, Jos. Bell, Byrd, Higgens, Amboni, Blum, Duplay, Bartleet, Andrews, and others. I have myself stretched in one case the musculo-spiral, and in another the median nerve, for traumatic neuralgia of the hand; in the latter case with permanent, but in the former with only temporary, advantage. I have also stretched the nerves of the brachial plexus, for the results of "concussion," with decided relief to the patient. Experimental researches in nerve-stretching made by Marcus, lead him to think that the effect is due to changes produced in the spinal cord, rather than in the sensory fibres of the nerves themselves. Quinquaud finds that there is a reflex influence exerted upon the corresponding nerves of the opposite side. According to the same writer, the production of complete anæsthesia is necessary to ensure success.

Reflex Paralysis, resulting from injuries of nerves, is a very interesting subject, but belongs more to the domain of physiology than to that of practical surgery; it has been specially studied by Prof. Brown-Séquard, by Dr. Mitchell, of this city, and by Dr. Echeverria, of New York.

INJURIES OF MUSCLES AND TENDONS.

Strains and Sprains of muscular tissue are of very frequent occurrence, and vary in severity from the slightest stretching to absolute rupture of some of the muscular fibres; the treatment consists in keeping the parts at rest, in the use of slightly stimulating embrocations, and in the internal administration (in cases occurring to patients of a rheumatic tendency) of Dover's powder with colchicum or iodide of potassium. Corrigan's button cautery may be applied if the pain be very persistent, while the atrophy and paralysis, which sometimes result, require faradization, shampooing, etc.

Subcutaneous Rupture of muscles and tendons may occur either from external violence, or from the forcible contraction of the muscle itself. Thus, the abdominal muscles are sometimes ruptured during the process of parturition, while muscular rupture is a frequent attendant upon the spasms of tetanus. Rupture of the sterno-cleido-mastoid muscle during birth, is, according to T. Smith, the cause of the so-called congenital tumor or induration of that muscle. Rupture of tendons is apt to occur from sudden and unusual exertions, especially on the part of persons past the middle time of life; thus, the tendo Achillis has been known to give away in elderly gentlemen who indulge in the juvenile amusement of dancing. The line of rupture may be through the muscle or through the tendon, though more commonly at their line of junction; more rarely the tendon may be separated from its point of insertion. The *symptoms* of this accident are sufficiently evident. The patient experiences a sudden shock, attended with a sharp pain (*coup de fouet*), and sometimes an audible snap; the power of using the part is lost; and usually a distinct depression or hollow can be felt at the line of rupture. If the part be the seat of variocose veins, thrombosis and milk-leg may follow, as pointed out by Verneuil. Effusion into the neighboring joints may ensue, as observed by De Santi, from irritation of the outer surface of the synovial capsule, due to infiltration of blood, as in cases of fracture. The *treatment* consists in placing the part in such a position as will relax the affected muscle or tendon, and allow its divided extremities to be approximated as closely as possible. Repair in these cases is effected, as shown by Paget, Adams, and Demarquay, by the development of a new tissue between the divided extremities, which in the case of a tendon gradually assumes the character of the original structure, but in the case of a muscle remains permanently as a fibrous band.[1] Rupture of the tendo Achillis may be conveniently treated by an apparatus consisting of a collar placed above the knee, with a cord which pulls up the heel of a slipper applied to the foot, so as to keep the gastrocnemius muscle thoroughly and constantly relaxed. Rupture of the extensor muscles of the thigh, or of the ligamentum patellæ, should be treated by keeping the limb in an extended position and somewhat elevated; after recovery, a posterior splint should be worn for some time, to prevent sudden flexion of the knee. In a case of rupture of the biceps recorded by Dr. Samuel Ashhurst, it was found sufficient to apply compresses and a figure of 8 bandage, and to support the arm in a sling. Paralysis or atrophy resulting from these injuries requires the use of friction, faradization, etc., as already described.

Open Wounds of tendons should be treated on general principles, care being taking to avoid gaping of the part by placing the limb in a suitable position, and by the use of sutures to approximate the cut extremities, if this seem necessary. If the *proximal* extremity of the cut tendon should be retracted out of reach, its *distal* end may be attached to a neighboring tendon, as advised by Denonvilliers, Tillaux, and Duplay. Annandale has successfully pared and reunited the tendo Achillis more than two months after its division.

Luxation of a Tendon from its sheath is occasionally met with, particularly in the case of the biceps, peroneus, and tibialis posticus muscles; the *treatment* consists in restoring the displaced tendon to its normal position by manipulation, and in endeavoring to prevent redisplacement by the use of a compress and bandage.

INJURIES OF THE LYMPHATICS.

These present, ordinarily, no features requiring special comment; in some cases, however, in which there is a varicose state of the lymphatic trunks (a condition usually associated with one of the varieties of Elephantiasis Arabum), wounds of the affected part are followed by a copious and sometimes troublesome flow of a milky fluid, constituting a traumatic form of what is known as *lymphorrhœa*. Such wounds are difficult to heal, and sometimes degenerate into obstinate fistulæ. Carefully applied pressure, and the use of caustic, or even of the hot iron, would seem, in such a case, more promising than any other remedy.

INJURIES OF BURSÆ.

These are chiefly of interest from the possibility of their being mistaken for injuries of adjoining articulations. Wounds of bursæ heal with obliteration of the sac. Should suppuration occur in a bursa, without external wound, the part should be freely opened, and treated as an ordinary abscess. Injuries of bursæ sometimes result in chronic structural changes which will be described in another part of the volume.

INJURIES OF BONES.

Beside *fractures*, which will be considered in a separate chapter, bones may be subjected to *contusion* and to alteration of shape (*bending*), without solution of continuity.

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[1] According to Demarquay, however, under favorable circumstances actual regeneration of muscular tissue may occur.

Contusion of bone has already been referred to in the chapter on gunshot wounds, as a consequence of which injuries it is not unfrequently met with. It may also occur, however, as the result of accidents met with in civil life, and is frequently productive of very serious effects as regards the limb, or even the life of the patient. The various inflammatory conditions of bone, which will be hereafter discussed, such as periostitis, necrosis, and osteo-myelitis, may all result from contusion, while in special localities, as in the skull, serious visceral complications may secondarily ensue. In the aged, shortening and atrophy may result from bone contusion, as is often seen in the neck of the femur;[1] this condition may be mistaken for fracture. The primary treatment of contusion of bone is to be conducted in accordance with the principles which guide the surgeon in the management of contusion of other parts. The operative measures which may be required by the after consequences of this form of injury will be referred to in another place.

Bending of Bone, apart from fracture, can only be met with in very early life, or under the influence of some morbid condition which diminishes the proportion of the earthy constituents of bone, as in cases of rickets or of osteo-malacia. The treatment consists in attempting to remove the deformity by the use of suitable splints and bandages. The splint may be applied to either the concave or the convex side of the limb, but in either case care must be taken to prevent sloughing at the points of greatest pressure.

Injuries of Joints.

Injuries of joints, apart from *dislocations,* which will be considered hereafter, may be classed as *contusions, sprains,* and *wounds.*

Contusions of joints are of frequent occurrence as consequences of falls, blows, etc., and if not very severe, and in healthy persons, are usually readily recovered from; in other circumstances, however, the results of these injuries may be very serious. Hip disease is not unfrequently traced to a fall or blow upon the hip, as its exciting cause, and I have known a simple fall upon the ice, in a boy of strumous constitution, to be followed by osteo-myelitis of the humerus, with suppurative disorganization of both elbow- and shoulder-joints, requiring eventually amputation at the latter articulation. The *treatment* of contused joints should consist in keeping the part at complete rest, and in applying cold, with leeches, if necessary; and, in the later stages, in affording support by means of an elastic bandage, and in the use of methodical friction and of the cold douche.

Sprains.—A joint is said to be *sprained,* when, as the result of a twist or other external violence, its ligaments are forcibly stretched or torn, without the occurrence of either fracture[2] or dislocation. This accident may occur in any joint, though it is most frequent in the wrist, ankle, and smaller joints of the foot. The condition may commonly be easily recognized. The position assumed spontaneously by the part is that in which there is least tension, the hand being slightly flexed and inclined to the ulnar side in the case of the wrist, and the foot being extended ("pointed toe") in the case of the ankle. The joint presents the usual evidences of inflammation, the swelling and heat being particularly marked, while the part, if not painful, is exquisitely sensitive to the touch. These symptoms may be developed in the course of from a few minutes to half an hour, though a patient with a sprained ankle may sometimes continue to go about for several hours, not being indeed conscious of the severity of his injury till he comes to remove his boot at night. The *prognosis* in the large majority of cases is favorable, though, in old persons, the joint may remain stiff and painful for many weeks or even months after the subsidence of acute symptoms. The articulation sometimes becomes the seat of chronic rheumatism, while more rarely, if the patient be strumous, suppurative disorganization of the part may ensue. The *treatment* in the acute stage consists in keeping the joint at entire rest, and in making cold or warm applications, as most agreeable to the patient. I have often, by the use of warm spirituous fomentations, such as the tincture of opium or tincture of arnica, succeeded in dispersing the swelling, and relieving the other symptoms of inflammation—stimulating them down, as it were—more quickly than by the use of evaporating lotions, as usually recommended. In the later stages the part must be well supported with a soap plaster and bandage, or an elastic stocking, and subjected to methodical kneading and friction (*massage*), and the use of the cold douche. *Massage* has been recommended in the acute stage, and is said by Dr. Graham, of Boston, to shorten the period of treatment very materially, but I confess that I should hesitate to employ it in a case of recent sprain. When a patient with sprained ankle is unable, from the nature of his avocations, to stay at home and keep the part at rest, it may advantageously be supported with a plaster-of-Paris bandage, which will allow of a certain amount of exercise without injury to the joint. Should the surgeon have the opportunity of seeing the case at an early period, before the occurrence of inflammatory symptoms, it might be proper to completely surround the joint with long and broad adhesive strips, superadding a gypsum bandage—a mode of treatment which has occasionally succeeded in *preventing* the occurrence of inflammation and its troublesome sequelæ; if this plan be adopted, however, the case should be very carefully watched, lest injurious constriction or even sloughing should result from the pressure employed.

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[1] Prof. Humphry, of Cambridge, denies the correctness of the theory that shortening of the cervix femoris occurs as a senile change.

[2] Under the name of *sprain-fracture,* Callender describes an injury consisting in the separation of a tendon from its point of insertion, with detachment of a thin shell of bone; such a case should, of course, be treated as an ordinary fracture in the same locality.

Wounds of Joints.—These injuries can usually be recognized without difficulty, either by the exposure of the articular cavity, or, if the wound be smaller, by the escape of synovia; if, however, these evidences be not present, it is an imperative rule of surgery that no exploration with the probe or otherwise should be instituted, lest the very complication that is dreaded should be induced by these manœuvres. The *prognosis* of a joint wound depends on the size and situation of the particular articulation which is affected, the nature of the wound itself, and the constitutional condition of the patient. Wounds of the smaller joints, such as of the fingers and toes, are commonly recovered from without difficulty, although anchylosis of the articulation usually results. Small incised wounds of even large joints may terminate favorably under expectant treatment, while lacerated wounds of the same joints, especially if complicated with dislocation or fracture, almost inevitably require excision or amputation. Again, in a strumous patient, a comparatively slight wound may give rise to such disorganization of a joint as would not ensue in the case of a perfectly healthy person.

Treatment.—In the case of a simple, uncomplicated wound of even so large a joint as the knee, the surgeon should make an attempt to save the limb. If a portion of the instrument which has caused the injury remain in the wound (as often happens in cases of needle puncture), it should be carefully extracted, and the wound then hermetically sealed with gauze and collodion, or with lint dipped in the compound tincture of benzoin. Millet recommends a dressing of finely powdered aloes, a substance much employed in joint wounds by veterinary surgeons. The patient should be kept in bed, with the limb at complete rest, the joint being surrounded with ice-bags. The diet should be unirritating, and opium may be freely administered. Under this treatment the wound may heal, and a useful articulation be preserved. If, however, the course of events takes a less favorable turn, as is apt to happen with patients in adult life, the whole joint may become acutely inflamed, that condition being then developed which is known as *traumatic arthritis.* This differs from the ordinary forms of arthritis, which constitute the "white swellings" so often met with in practice, in that, in them, the disease often originates in the ligaments or the bone itself, while in the traumatic form the synovial membrane is invariably first inflamed, and the other tissues become involved secondarily. When *traumatic arthritis* occurs in a case of joint wound, the treatment above directed should be somewhat changed; the use of cold may be abandoned, and warm fomentations or cataplasms substituted, while a few leeches may be applied to the neighborhood of the joint, and calomel and opium exhibited internally. At the same time the strength of the patient must be sustained, by the administration of concentrated food, and even stimulants if necessary. Any abscesses which form around the joint should be opened as soon as they are detected, while, if suppuration occur within the joint itself, the question of excision or of amputation may again arise.

Free incisions into suppurating joints, as recommended by Mr. Gay, are often of the greatest service. To be effective, they should be *free*—mere punctures are worse than useless—and should be so situated as to allow of perfect drainage; it is not, however, necessary to slit up a joint from side to side, and it should not be forgotten that, as Mr. Holmes puts it, these incisions, "if they do no good, will certainly do harm." The object and the *sole* object of opening a suppurating joint is to secure free drainage, and this object can be better accomplished by an incision of moderate size judiciously placed, than by a larger one in another part of the joint. Drainage may be assisted, as suggested by Mr. Holmes, by the introduction of a Chassaignac's tube, a bent probe, or, which would be still better, a coil of fine wire, as recommended by Mr. Robert Ellis. Should this treatment prove successful, the inflammatory symptoms will gradually subside, and the suppuration lessen in amount, the patient eventually recovering with a probably stiff, but otherwise useful, limb; during convalescence the joint should be kept in such a position as will allow the limb to be of most use, should anchylosis occur. If, however, the patient's condition does not improve after opening the joint, the surgeon should not hesitate to resort at once to amputation, or, in some cases, excision; for, although the prognosis of operative interference, under such circumstances, is less favorable than in cases of chronic disease, still, as it offers the patient his only chance for life, it should be unhesitatingly resorted to.

Amputation or Excision in Cases of Joint Wound.—If operative treatment be required, either as a primary procedure or in a subsequent stage on account of the occurrence of suppuration within the articulation, the choice between amputation and excision will depend in a great degree upon the particular joint concerned. In the upper extremity, amputation can be rarely required, except for special circumstances connected with the constitutional condition of the patient, and excision, either primary or secondary, should be preferred, in cases which require any operation at all. In the lower extremity the case is somewhat different; the *hip-joint* is so deeply seated that it is scarcely ever wounded except by gunshot injury, in which case, for reasons already given, primary excision is the mode of treatment to be adopted. Wounds of the *knee-joint* are among the most serious injuries met with in civil practice; if complicated with fracture or dislocation, they should, I think, be considered as cases for amputation, although exceptional instances do undoubtedly occur in which recovery without operation follows, even under these unfavorable circumstances. *Excision* of the knee-joint, for traumatic causes, is not a very promising operation; still, in a young and healthy person, if the destruction of parts were comparatively slight, it might be at least a justifiable procedure. M. Spillman, who rejects knee-joint excision in military surgery, yet considers it a suitable operation as applied to cases of injury met with in civil life. Eleven such cases which he has collected, excluding gunshot wounds, gave six recoveries, three deaths, and two consecutive amputations (*Archives Gén. de Médecine*, Juin, 1868, pp. 681–701). Five cases of total excision for compound fracture, collected by Penières, gave four deaths and but one recovery, while six operations for joint wound, without fracture, gave but one death and five recoveries; as justly observed, however, by this writer, these cases might, perhaps, equally well have recovered without operation. Culbertson's tables include 28 cases, with 17 recoveries and 11 deaths. When an attempt has been made to save the knee-joint, but without success, amputation should be unhesitatingly performed, as offering the only remaining chance of preserving life. One point worthy of notice in connection with wounds of the knee, is the frequent occurrence of suppuration above the joint, abscesses being formed which dissect up the muscles of the thigh to a considerable extent, before giving evidence of their existence. It is this deep-seated destruction of the tissues of the thigh which constitutes one of the chief dangers of wounds of the knee-joint, and which renders any operation performed under these circumstances very apt to terminate unfavorably. Wounds of the *ankle* are attended with less risk than those of either hip or knee, and recovery may often be obtained without operation, though in other cases excision or amputation may be required either primarily or secondarily. Spillman has collected sixty-eight cases of complete or partial excision of the ankle for compound fracture or dislocation, the results having been ascertained in sixty-six. Fifty-one patients recovered with more or less useful limbs, two recovered after amputation, and thirteen died (two of these having been likewise previously amputated); the mortality of the operation is, according to these figures, about twenty per cent. Culbertson's statistics are more favorable, 154 cases giving but 19 deaths, a mortality of only 12.3 per cent. In the conservative treatment of these injuries it is of great importance to support the foot, so that the patient after recovery may be able to walk properly, and may not be left with an extremity anchylosed in the position of a *pes equinus*.

I have already referred (p. 59) to the proposal to tie the main artery of a limb, as a means of preventing or curing traumatic arthritis; recovery has indeed followed ligation under these circumstances, but no sufficient evidence has been adduced to show that the good result was in any degree due to the operation, which, beside being unphilosophical in conception, evidently adds an additional risk, without any compensating prospect of benefit. I have, moreover, been assured by distinguished army surgeons, who saw the plan fairly tried during our late war, that it proved then as unsuccessful in practice as it is unscientific in theory.

CHAPTER XI.

FRACTURES.

FRACTURE is the most common form of injury to which the bones are exposed, and, as such, becomes a subject of the deepest interest to every practising surgeon. Moreover, no injuries require more care and judgment in their treatment than fractures, and no cases contribute, more than these, to establishing the fame or the discredit of the surgeon. A man who gets well with a crooked or shortened limb, is very apt, whether rightly or wrongly, to lay the blame of it upon his doctor, and though cases do undoubtedly occur in which the most skilful and attentive surgeon may fail in obtaining a satisfactory result, there can be no question that a great many bad cures of fracture are directly traceable to ignorance or neglect upon the part of the practitioner.

CAUSES OF FRACTURE.

These may be divided into the *exciting* and the *predisposing* causes.

Exciting Causes.—The exciting causes of fracture are *external violence* and *muscular action.*

1. *External Violence* may act *directly* or *indirectly*. Gunshot fractures are perhaps the best examples of fracture as the result of *direct* violence, while fracture of the clavicle from a fall on the shoulder, or of the radius from a fall on the hand, may be taken as illustrations of the injury as produced by *indirect* violence. Fracture by *counter-stroke* (the *contre-coup* of French writers) is a form of the fracture by indirect violence, in which the force is applied to one side or extremity of the bone, or system of bones, which are so united and fixed that, by the natural elasticity of the parts, the force is transmitted, and produces its effect, not at the point to which it was applied, but at a point opposite. Familiar examples of fracture by counter-stroke are those of fracture of the base of the skull, from force applied to the top of the head, of the frontal bone, from a fall upon the occiput, or of the sternum, from violence applied to the back. The subject of *contre-coup* or *counter-stroke*, has been involved in some confusion by the various meanings which different authors have given to the term; as used here, it is to be understood as denoting merely a variety of injury from indirect violence, the mechanism of which is explicable by simple and well-understood physical laws, depending entirely upon the structure and connections of the bones and other parts involved.

2. Fracture by *Muscular Action* is not of very unfrequent occurrence, though the cases in which fracture is produced by pure *divulsion*, or tearing asunder the fragments, are rarer than is commonly supposed. Indeed, the only instances of the kind with which I am acquainted, are those rare cases in which fracture of the sternum has occurred during the acts of parturition, vomiting, etc. In the more commonly quoted instances of fractured olecranon and fractured patella, the mechanism is somewhat different, the bones (as justly remarked by Dr. Packard) giving way like over-bent levers, across the condyles respectively of the humerus and femur, though the *fracturing force* in these cases, as in those of fractured sternum, is muscular contraction.

Predisposing Causes.—The predisposing causes of fracture may pertain to the bone itself, or to the general condition of the patient. Thus, the *situation* of a bone influences its liability to fracture; the clavicle is much oftener broken than the scapula, and the lower than the upper jaw. Again, the *function* of a bone may predispose it to fracture; the bones of the lower extremity, which support the trunk, or those of the upper extremity, which are constantly engaged in the active employments of life, are more liable to fracture than the vertebræ or sternum, the functions of which are different. The following table, condensed from the statistics of Lonsdale, Norris, and Malgaigne, will exhibit the relative frequency of fracture in different parts of the body, in the Middlesex Hospital, Pennsylvania Hospital, and Hôtel Dieu:

Seat of Fracture.	Lonsdale.	Norris.	Malgaigne.	Seat of Fracture.	Lonsdale.	Norris.	Malgaigne.
	6 years	10 years	11 years		6 years	10 years	11 years
Skull, ...	48	46	53	Humerus, . .	118	252	310
Nasal bones, ...	13	3	12	Radius, . . .	197		160
Upper jaw and malar, .	1	...	3	Ulna, . . .	96		38
Lower jaw, ...	32	19	27	Radius and ulna	93		107
Sternum, ...	2	5	1	Hand, etc., . .	116	9	71
Ribs and costal cartilages	357	46	263	Thigh, . . .	181	133	303
Vertebræ, ...	8	8	11	Patella, . . .	38	16	45
Pelvis, sacrum, etc., .	7	6	9	Tibia, . . .	41	295	29
Clavicle, ...	273	84	225	Fibula, . . .	51		108
Scapula (or shoulder), .	18	10	12	Tibia and fibula	197		515

Among the predisposing causes which pertain to the general condition of the patient, *age* occupies a prominent place. There can be no question that the old are more apt to be the subjects of fracture than the young, partly on account of the greater brittleness of their bones, and partly from the general rigidity of ligaments and muscles which attends advancing age, and which renders the entire frame less elastic and yielding, and therefore more liable to this form of injury. No age is, however, exempt from fracture, and not a few instances are on record in which this has occurred even during fœtal life.[1] The circumstance that old age predisposes to the occurrence of fracture, does not contravene the well-known fact that most of these injuries are met with in those in early adult life, for the simple reason that such persons are most engaged in active employments, and are, therefore, most exposed to all forms of injury resulting from external violence. *Sex*, as might be supposed, exercises an influence on the liability to fracture, men, from the nature of their occupations, being more apt to have broken bones than women; for a similar reason, the *right* side of the body is more exposed to fracture than the *left*. Certain forms of cachexia, or certain diatheses, may be considered as predisposing causes of fracture. *Rickets* undoubtedly exercises a powerful influence in this way, as do *osteomalacia, cancer, syphilis, scrofula, gout, locomotor ataxia*, and *general paralysis of the insane*. Some very remarkable cases are on record illustrating the fragility of bones under certain conditions: Gibson, Arnott, Tyrrell, Lonsdale, and H. Thomson, have described such cases, but the most remarkable of all is that published in the *Journal des Savants* for 1690, and which appears to be the same as one quoted by Malgaigne from Saviart, in which an apparently healthy young woman of thirty, during three months' confinement to bed, sustained, it is said, fractures of every bone in the body. Esquirol is said to have possessed a skeleton which exhibited traces of more than two hundred fractures.[1] In many of these cases union readily took place, but in one mentioned by Stanley, and in that of H. Thomson (in which, indeed, the bones are described as *separating* rather than *breaking*), the fractures appear to have remained ununited.

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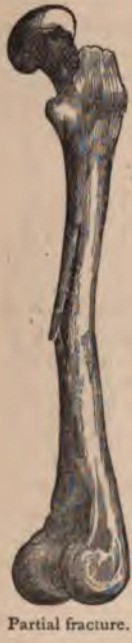
[1] Depaul, however, believes that supposed intra-uterine fractures are really cases of defective ossification, and not of injury.

VARIETIES OF FRACTURE.

Fractures may be Complete or Incomplete; these names sufficiently express their own meaning. The form of *incomplete* fracture usually met with in civil life is the *partial* or "*green-stick*" fracture, in which some of the bony fibres have given way, while the rest have yielded to the force, bending but not breaking. In military practice, incomplete fractures are occasionally produced by blows from sabres, but more often by gunshot wounds, the principal varieties being the *fissured* fracture, the *grooving* fracture, in which a piece is cut out from the side of a bone, and the *button-hole* or *perforating* fracture, in which a piece is fairly punched out from the centre of a bone. These terms (*complete* and *incomplete*) are principally used in reference to the long bones; in the case of flat bones, as of the skull, many of the fractures met with in civil life are incomplete. The most usual and the most important division of fractures is into *simple* and *compound*.

FIG. 104.



Partial fracture.

A Simple Fracture, as the term is used in this book, is a *fracture in which there are but two fragments, and which does not communicate with an open wound.* This definition, which seems to me to correspond with the meaning usually attached by surgeons to the term *simple fracture,* is essentially the same as that given by Mr. Erichsen, but differs from the definitions given by Prof. Hamilton and Prof. Gross, the former author using the term as equivalent to Malgaigne's *single* fracture, without regard to its subcutaneous character, while the latter regards merely the absence of external wound, without reference to the number of fragments. The classification adopted by Mr. Hornidge, in Holmes's *System of Surgery* (which would make this form the "simple, single fracture"), is perhaps the most strictly correct, but is almost too complicated for common use.

Compound Fractures are *fractures which communicate with the external air through a wound:* this wound is usually, though not necessarily, an external or cutaneous wound; a fracture of the jaw may be compound from a wound through the buccal mucous membrane.

Comminuted Fractures are those in which there are more than two fragments, the lines of fracture, however, intercommunicating with each other and occupying the same general position as regards the bone affected. A *multiple* fracture, on the other hand, is one in which the bone is the seat of two or more distinct fractures not necessarily connected with each other;

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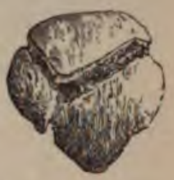
[1] I have myself met with a case in which, without apparent reason, seventeen fractures had been sustained by the bones of the right lower extremity; when I saw the patient, multiple enchondromata had been developed in the foot and ankle.

thus the radius may be broken just below its head and again above the wrist, or the tibia through the malleolus and again just below its tuberosity. A *double* fracture is a multiple fracture in which the solutions of continuity are but two in number. Comminuted and multiple fractures may or may not be *compound*, and a multiple fracture may be compound at one seat of lesion and not at the other. When the term *comminuted fracture* alone is used, it is understood that there is no communication with an external wound; if there be such communication, the injury becomes a *compound comminuted fracture.*

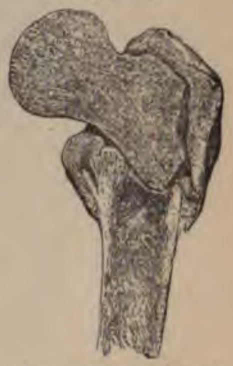
FIG. 105.



Comminuted fracture of the patella.

Complicated Fractures are *fractures which are accompanied by some other serious injury of the same part.* Thus a fracture may be complicated by dislocation of a neighboring joint, by rupture of an important artery, or by a severe flesh wound which does not communicate with the seat of fracture. Some authors speak of fractures being *complicated* (in this technical sense) by any of the various lesions to which the human frame is subject, but this, it seems to me, is incorrect; thus it would be wrong to describe a fracture of the *right* thigh as *complicated* by a dislocation of the *left* shoulder, or a fracture of any of the extremities as *complicated* by a wound of the pleura or lung, though the latter lesion, if produced by the sharp fragments of a broken rib, would be a technical complication of that injury, which would then be properly called a *complicated fracture* of the rib.

FIG. 106.



Impacted fracture, through the trochanters of the femur. The upper fragment is wedged into the lower.

Impacted Fractures are those in which one fragment is driven into and fixed in the other.

Intra-periosteal Fracture is the term applied to a fracture unaccompanied by laceration of the periosteum; it is a form of injury rarely met with except in certain flat bones, as those of the skull, and, indeed, the creation of this subdivision seems to me to be of very little practical utility.

Direction of Fracture.—Fractures are also classified in accordance with the *direction* in which the separation of the bony fibres occurs; thus fractures are said to be *transverse*, *oblique*, or *longitudinal*.

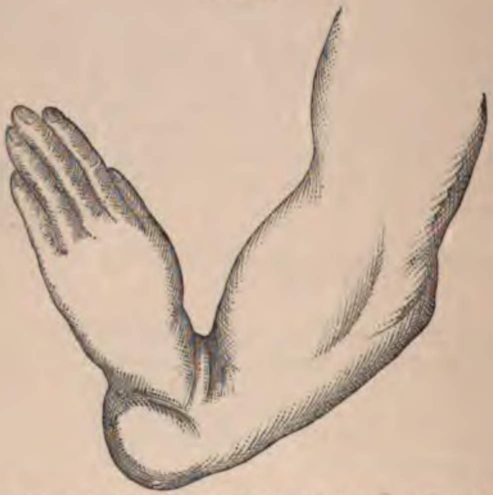
A *Transverse Fracture* is one in which the general line of separation is transverse, or in a plane at right angles with the long axis of the bone. A perfectly transverse fracture in a long bone is very rarely met with, the line of separation being almost always more or less oblique; a variety of the transverse is the *serrated* fracture, in which the fragments present corresponding indentations which render it comparatively easy to maintain them in apposition. Transverse fractures usually result from direct violence or from muscular action.

The *Oblique Fracture* is the form most commonly met with in the long bones. The plane of fracture may, of course, vary greatly in different cases; thus a fracture is said to be oblique from before backwards and from without inwards, etc. Oblique fractures are commonly caused by indirect violence.

Longitudinal Fractures are those in which the line of separation runs in the general direction of the long axis of the bone. This form of fracture is comparatively rare in civil life, but is frequently met with as a result of gunshot injury, especially since the general introduction into warfare of the improved conoidal ball. Longitudinal fractures commonly occur in the shafts of long bones, and usually do not extend beyond the epiphyseal lines, though occasionally they pass through the epiphyses into the neighboring joints. Several other divisions are made by French writers, according to the peculiar form of the fracture, but the above are sufficient for practical purposes.

Separation of Epiphyses.—This is a form of injury which may fairly be classed among fractures, the symptoms and treatment of the two sets of cases being pretty much the same. Separation of an epiphysis may take place at either end of the humerus, the femur, or the tibia, and at the lower extremity of the radius; it is also frequently seen in the case of certain bony processes, as the acromion and olecranon; while in certain flat bones, as the sternum and os innominatum, similar injuries are met with, consisting in a separation of the osseous structure into its original constituent parts, in the lines of cartilaginous junction. Epiphyseal separation can of course only occur before complete ossification has taken place; hence, in the long bones it is not met with beyond the age of twenty or twenty-one, though in other situations, as in the acromion, it may occur at a much later period. The direction of an epiphyseal separation is transverse, and from the proximity of the epiphyseal lines to the articulations, these injuries are liable to be confounded with dislocations. The *diagnosis* in such cases can usually be made, by taking care, in the examination, to grasp the epiphysis itself firmly with one hand, while the other exercises the movements of flexion, rotation, etc., when, if the case be one of separated epiphysis, the lesion can readily be recognized as being above or below the line of the joint, as the case may be. Epiphyseal injuries are apt to be followed by arrested growth of the affected bone, and thus sometimes cause great deformity, as shown in Fig. 107.

FIG. 107.



Deformity resulting from injury of radial epiphysis in childhood. (From a patient in the Episcopal Hospital.)

SYMPTOMS OF FRACTURE.

Deformity.—The most prominent, and one of the most characteristic symptoms of fracture is *deformity* or *displacement*. The *Causes of Displacement*, in cases of fracture, have been the subject of much dispute among systematic writers. Without entering into a minute discussion of this matter, I may say, in general terms, that the causes of displacement are fourfold, viz., 1, the force that produces the fracture; 2, the action of surrounding muscles; 3, the weight of the limb below the seat of fracture; and 4, the natural elasticity and resiliency of the ligaments and other soft tissues above the seat of fracture.

1. *Deformity from the influence of the fracturing force* is seen in cases of depressed fracture of the skull, in cases of partial fracture of the clavicle with inward angular deformity, and in cases of impacted fracture generally.

2. *Muscular action* is the most common cause of displacement in cases of fracture. It is seen in the shortening which accompanies almost all fractures of the extremities, and in the rotatory displacement common in fractures of the femur, radius, etc. It is probably the sole cause of displacement in cases in which the fracture itself has been caused by muscular action, as in fractures of the patella or olecranon. Beside the ordinary contraction of the muscles around the seat of fracture, there is often a spasmodic condition induced by the irritation caused by the sharp fragments of the broken bone.

3. *Displacement by the weight of the limb* below the seat of fracture, is seen in the dropping of the arm and shoulder, in cases of fractured acromion or fractured clavicle. It assists the action of the rotator muscles, in producing eversion of the foot, in fractures of the lower extremity.

4. Finally, the *natural elasticity* of the soft tissues *above* the seat of fracture, is seen as a cause of deformity in the projection of the inner fragment of a fractured clavicle, when, as pointed out by Anger, the weight of the arm being taken off by the fracture, the inner end of the clavicle is jerked upwards by the normal resiliency of its ligamentous and other attachments.

Direction of Displacement.—The displacement in cases of fracture may take place in various directions; thus, there may be *angular, transverse, longitudinal*, or *rotatory* displacement.

1. *Angular displacement* is usually due in the first place to the action of the fracturing force, but is kept up or may be originally produced by muscular action. Thus, in fracture of the thigh there is often an angular displacement outwards and forwards, due to the fact that the most powerful of the femoral muscles are those on the back and inner side of the limb. This is the form of displacement met with in partial or "green-stick" fractures, and it may also accompany oblique or comminuted fractures, or those in which there is impaction.

2. *Transverse displacement* is comparatively rare; it occurs principally in cases of serrated fracture of the long bones, in which the separation has not been sufficient to allow overlapping from muscular contraction. It is also met with in fractures connected with joints, as in splitting fractures of the condyles of the humerus or femur.

3. *Longitudinal displacement* is displacement *in the direction of the long axis of the bone at the point of fracture.* It may consist in *shortening*, or in *lengthening*. *Shortening* occurs principally in oblique fractures of the long bones, and is due to muscular action, often assisted by the nature of the fracture, which allows one fragment to slide upon the other as upon an inclined plane. When the shortening is so great that the upper end of the distal fragment is drawn above the lower end of the proximal fragment, there is said to be *overlapping*, and the more prominent fragment is said to *ride* the

other. The overlapping often amounts, in fracture of the thigh, to several inches. Another form of *shortening* is due to impaction; this is often seen in fracture of the cervix femoris, the shortening being principally in the direction of the axis of the *neck* of the bone, not of its *shaft;* hence the deformity in such a case is comparatively slight. The form of longitudinal displacement which consists in *lengthening*, is chiefly seen in cases of fractured patella, fractured olecranon, fractured calcaneum, etc., in which the fragments are often widely separated by muscular action; it is, however, as pointed out by Malgaigne, occasionally met with in fractures of the articular extremities of the long bones, as of the fibula, when it is a secondary condition dependent on antecedent rotatory displacement.

4. *Rotatory displacement* consists in one of the fragments being twisted upon its own axis; this form of displacement may be due to muscular action, or to the weight of the limb below the seat of fracture. This displacement is constantly seen in fracture of the upper part of the femur, when the *lower* fragment is rotated outwards by the powerful external rotator muscles of the thigh; in fracture of the bones of the leg, by the action of the same muscles, the *upper* fragments, moving with the femur, are subjected to rotatory displacement. So in fracture of the radius, particularly if above the insertion of the pronator radii teres, the upper fragment is usually rotated outwards by the biceps and supinator brevis.

Displacement in cases of fracture may be confused with deformity from other causes; thus a periosteal node or an exostosis may closely simulate angular displacement; shortening may result from old joint disease, or from contracted tendons; the position which a joint assumes when the seat of sprain, may be mistaken for rotatory displacement; while the transverse, or, indeed, any of the varieties of displacement may be due to dislocation and not to fracture. Hence, the surgeon, in making his diagnosis, must not rely upon the appearances presented to the eye, or even upon mere tactual examination. The limb involved should be carefully and repeatedly measured between known fixed points, and compared with the corresponding unaffected limb; and in cases of doubt, not only the injured limb, but the bone itself should be accurately measured and compared with its fellow of the opposite side.

Mobility is often a striking and easily recognized symptom of fracture; the part which gives support to the limb is broken, and the limb can be bent in any direction. In fractures, however, of the leg or forearm, when but one of the two bones is broken, the other acts as a splint, and hinders the development of this symptom; again, in serrated, and especially in impacted fractures, there will often be no undue mobility; or the swelling of the soft parts may be so great as to render the mobility of a fracture, especially if near a joint, difficult of recognition. On the other hand, dislocation, which is usually characterized by *immobility* of the affected joint, may, if there be much destruction of the articular ligaments, be accompanied by positive increase of mobility, and thus simulate fracture. But in the continuity of a bone, at a distance from its articular extremities, mobility, *when present*, is a sign of the greatest value, and may, indeed, be considered as almost pathognomonic.

Crepitus is another symptom of great importance, and when existing in connection with undue mobility, may be looked upon as establishing the presence of fracture. Crepitus or crepitation is the grating sensation produced by rubbing together the rough ends of the fragments. It is *felt* as well as *heard*, and is usually recognized without difficulty; it must not be mistaken or the grating produced by moving diseased joints, nor for the crackling due to effusion in the tendinous sheaths, nor yet for the crepitation of traumatic emphysema, each of which conditions may, under certain circumstances, closely simulate the true crepitus of fracture. The diagnosis might, perhaps, be aided in such cases, as suggested by Lisfranc, and more recently by Laughlin, of Indiana, by the use of the stethoscope. The non-existence of crepitus is no evidence that a bone is not broken, and its absence may be due to several causes: thus, the fragments may overlap to such a degree that their rough ends are not in contact—a condition often met with in fracture of the thigh, when it is necessary for an assistant to make extension before the fragments can be brought together and crepitus produced; or the fragments may be widely separated—as in cases of fractured patella; or a portion of a muscular tissue may be caught between the fragments, and prevent crepitus. In partial fracture, there is no crepitus; nor in impacted fracture, as long as the impaction continues.

Pain and Tenderness are symptoms of fracture, but may be equally due to so many other causes, that they cannot be considered as diagnostic. In some cases, however, *persistent, localized tenderness* is a sign of some value, especially in cases of partial or impacted fracture, in which the more characteristic symptoms are absent.

Loss of Function used to be considered an important symptom of fracture. Velpeau, however, showed that a fractured clavicle interfered with raising the arm to the head, merely by the pain caused by the act; and Gouget, a French army surgeon, has shown the same thing as regards the power of walking, after fracture of the patella (*Rec. de Mém. de Méd. de Chir. et de Phar. Mil.*, Mai, 1865, p. 394). I have myself known a man with fracture of both bones of the leg, to walk about the ward, when under the influence of mania a potu, using his fracture-box as a boot, and apparently not feeling any inconvenience from his injury.

Muscular Spasm is not an unfrequent accompaniment of fracture, though, of course, in no degree a diagnostic symptom: it is produced by a reflex condition, due to the irritation produced by the sharp extremities of the fragments.

Numbness is occasionally met with in cases of fracture, and is produced by simultaneous injury, or subsequent compression, of neighboring nerves.

Extravasation and **Ecchymosis**, to a greater or less extent, occur in almost every case of fracture: the degree of ecchymosis is often much greater after a few days, than when the injury is first received, and may then (especially if accompanied by much vesication, as it is apt to be if the soft parts have been much bruised) be mistaken by a hasty observer for incipient gangrene. When extravasation proceeds from a ruptured artery, giving rise to a traumatic aneurism, it constitutes a very serious complication of fracture. When the extravasation reaches to the neighboring joints, *intra-articular effusion* results, as pointed out by Gosselin, from irritation of the outer surface of the synovial capsule; this symptom is, therefore, usually met with some hours or even days after the occurrence of the fracture.

DIAGNOSIS OF FRACTURE.

The diagnosis of fracture can usually be made without much difficulty by attending to the symptoms above enumerated, the first three of which, when coexisting, may indeed be considered as pathogonomic. In cases of partial and of impacted fracture, the surgeon has not the evidence furnished by crepitus and mobility, and must rely upon the other signs of fracture, especially deformity and localized tenderness. Again, in cases where but one of several bones is broken, as in the hand or foot, the diagnosis is more obscure, especially if there be much swelling of the soft parts. In such a case, the surgeon carefully explores the surface, by making firm but gentle pressure upon each part in succession, and is thus enabled to detect any abnormal prominence, and often to elicit crepitus which could not otherwise be obtained. If the metacarpus or metatarsus be involved, each bone should be successively grasped by its extremities, and so manipulated as to render evident any fracture which may be present. As it is of great importance in any case of suspected fracture that the surgeon should arrive at a correct diagnosis, his examination should always be made deliberately and systematically. The deformity, mobility, impairment of function, pain, etc., should be successively noted, before proceeding to the manual examination which is to determine the existence or non-existence of crepitus. In this final part of the investigation, preliminary extension being made by an assistant, if necessary, the surgeon grasps the limb above and below the suspected seat of fracture *firmly*—so that he controls the bone as well as the flesh, and gently moves his hands in various directions, so that if there be a fracture, the ends of the fragments must rub against each other. It is scarcely necessary to say that, in this examination, all rough and needless manipulation is to be positively interdicted. If true bony crepitus be once elicited, it is sufficient, in connection with the other symptoms, to establish the diagnosis; and nothing can be more reprehensible than for a surgeon to persist, in spite of the pain thereby caused, in endeavoring again and again to renew this evidence, thus appearing more anxious to make a clinical demonstration for himself or for the bystanders, than to relieve the sufferings of his patient. The detection of crepitus may, as already mentioned, sometimes be facilitated by having recourse to auscultation.

The examination of a case of suspected fracture should be made as soon as possible after the time of reception of the injury, as the diagnosis is then more easy than if œdema and inflammatory swelling have already occurred. If, however, the surgeon do not see the case in an early stage, it is often judicious to defer any minute examination, treating the case as one of fracture until the swelling has subsided, when, if there be really no bone broken, at least no harm will have been done by the delay. Or, if for any reason it were important to ascertain the nature of the case at once, the plan recommended by Rizet, a French army surgeon, might be tried. This plan consists in endeavoring to disperse the swelling by systematic friction and kneading (*massage*), in the course of which proceeding, the fracture, if there be one, will become evident. Under certain circumstances, the use of an anæsthetic would be justifiable, in order to facilitate the diagnosis (see page 73).

In any case of doubt, it is safe to presume that the worst has occurred, and treat the case as one of fracture. It is remarkable what severe injuries of bone may exist, and yet, for a time at least, escape attention; Mr. Erichsen gives a remarkable case of compound comminuted fracture of the humerus, which, though carefully examined by himself and others, was not detected until the eighth day, and I can myself recall a case in the Pennsylvania Hospital, in which the swelling of the part prevented the recognition of anything further than that the patient had a fracture of both tibia and fibula, and yet in which (death taking place soon after from mania a potu) an autopsy showed that the bones were broken into at least a dozen fragments.

PROCESS OF UNION IN FRACTURED BONES.

In order to understand the process of repair after fractures, it will be necessary to pause for a few moments to consider the natural process of growth and maintenance of bone in its normal condition. This subject has been most thoroughly and carefully studied by Ollier, of Lyons, to whose elaborate and admirable Treatise on the Regeneration of Bones I would respectfully refer the reader for a detailed exposition of the whole subject of bone pathology. Bones grows in length by the development of bone cells from the epiphyseal cartilages, or cartilages of conjunction, and in thickness by the development of bone cells from the inner or *osteo-genetic* layer of the periosteum; while this peripheral thickening is going on, there is a simultaneous conversion of the innermost layers of bone into medulla or marrow, and hence the medullary cavity enlarges as the bone grows. Turning now to consider the effects of any traumatic irritation upon the constituents of bone, we find the various nutritive and formative changes which were described as parts of the inflammatory process (see Chap. I.), taking place in the periosteum, the bone tissue proper, and the medulla. *Direct* irritation of either periosteum or medulla is apt to result in giving rise to what was described as the second formative change of inflammation, the formation of pus, or suppuration: *indirect* irritation, however, whether propagated from the bone or from the external soft parts, gives rise (usually) only to the earlier changes, viz., temporary hypertrophy, and the formation of lymph. In the case of the periosteum, the effect of propagated traumatic irritation is to cause a hyperplasia of the deep or osteo-genetic layer, manifested by swelling, and ultimately resulting in an increased production of new bone; in the marrow, the irritation, if not excessive, results in induration and a local retrograde metamorphosis into bone. Finally the bone tissue itself responds to the stimulus, and becomes *medullized* (assuming the character of granulations), proliferation of its cells takes place, and hypertrophy, temporary or permanent, results, with (if the irritation continue) the various changes which will be hereafter considered under the head of osteitis. These are not mere theoretical views, but have been adopted by Ollier after numerous carefully conducted and often repeated experiments upon the lower animals, as well as after extended clinical observation.[1]

Taking now the simplest case of fracture—an *intra-periosteal* fracture, so called—the process of repair can be seen at a glance. The traumatic irritation propagated from the broken bone causes swelling of the periosteum, active proliferation, and formation of a sheath of new bone around the seat of fracture; this is the "*ensheathing*" or "*ring callus*" of surgical writers. At the same time the medulla feèls the effect of the irritation, becomes hardened and partially ossified; this constitutes the "*interior*" or "*pin callus*." Lastly, the osseous tissue itself undergoes cell proliferation, and union of the fragments takes place, *mutatis mutandis*, precisely by the same process that we have already studied in considering wounds of the soft tissues. The new material which is thus developed between the fragments themselves, constitutes what Dupuytren called the *intermediate, permanent,* or *definitive callus*, in contradistinction to the *ensheathing* and *interior* forms of callus, which are *temporary* or *provisional.*

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[1] It is but right to say that a different explanation is given by Billroth; according to this distinguished surgeon and pathologist, the periosteum possesses no peculiar osteo-genetic power, and the formation of callus is due not to proliferation of previously existing cells, but to an accumulation of *wandering cells*, which, following Cohnheim, he looks upon as white blood corpuscles escaped from the vessels. The same difference of opinion, in fact, prevails with regard to the pathology of inflammation and repair in the osseous tissues, that has already been noted with regard to those processes in the soft structures of the body. According to Feltz, bone, periosteum, and medulla, are all restored by means of an "embryo-plastic" tissue, which differs from the connective and medullary tissues, but is of an embryonic character analogous to that met with in fœtal life, and probably results from a "direct genesis." (Robin, *Journ. de l'Anat.*, etc., Juillet–Août, 1876.) Dr. H. O. Marcy believes that the periosteum is destroyed at the seat of fracture, and that repair takes place by exudation of "plastic or germinal material" and the formation of a new periosteum. J. Greig Smith (*Journ. of Anat. and Physiol.*, Jan., 1882) believes that true bone is developed, in cases of fracture, by the medullary structure, but that the change in the periosteum is rather calcification than true ossification.

This explanation is applicable to the process of repair as seen in every variety of fracture. The new formations from the periosteum and medulla gradually disappear, the ensheathing callus is partly absorbed and partly incorporated in the bone, in the process of its normal maintenance, while the ossified medulla, or interior callus, undergoes rarefaction and medullization, so that in time the continuity of the marrow cavity is again restored, and the whole bone resumes its pristine appearance. In the case of fracture unaccompanied by displacement, the periosteal and medullary new formations may be so small in amount and so temporary in duration, as to escape observation; this is seen in certain serrated, impacted, and partial fractures, and is often spoken of as union by intermediate callus alone. On the other hand, the fragments themselves sometimes fail to unite, the sole bond of union being the provisional (though in these cases not temporary) callus, resulting from the action of the periosteum or medulla. In cases in which there is great displacement, especially in neglected fractures of the thigh, very large and thick bands of callus are often seen, stretching across and uniting the fragments which are themselves widely separated. The time occupied by the process of repair varies, of course, according to the size of the fractured bone and other extraneous circumstances. For the first few days, no apparent change occurs in the neighborhood of the fracture, nature being apparently engaged in repairing the injury of the soft parts, causing the absorption of effused blood, etc. The formation of the provisional callus usually begins during the second week, and by the end of the third or fourth week this new structure has commonly attained sufficient bulk and strength to prevent displacement by any moderate degree of force. The definitive union of the fragments is not completed until a later period—sometimes many months subsequently. In certain situations, or under certain circumstances which will be considered hereafter, bony union does not take place, and the fragments are connected by fibrous tissue only. In cases of compound fracture, the process of union, though the same, is much slower in its progress, being delayed by the occurrence of granulation, of suppuration, and often of necrosis, and presenting similar differences to those which are observed in the healing of open, as compared with that of subcutaneous wounds. *Cartilage* is occasionally met with in callus; it is, however, but a temporary constituent, due to excess of irritation. *Separated epiphyses* unite as fractured bones: the part usually remains permanently thickened, while, from the injury to the cartilage of conjunction, the growth of the bone in length is permanently interfered with. (See Fig. 107.) For further information on the interesting subject of the repair of bones after fracture, I would respectfully refer the reader to the writings of Dupuytren, Malgaigne, Stanley, and Paget, but especially to the work of Ollier, already referred to.

TREATMENT OF FRACTURES.

The general indications to be met, in the treatment of all fractures, may be said to be—1, to reduce or set the fracture as soon as possible; 2, to prevent a recurrence of displacement; and 3, to see to the well doing of the part affected, and to look after the constitutional condition of the patient. I shall first consider the general principles which should guide the surgeon in the treatment of simple fractures, then the modifications of treatment required by the principal complications of simple fracture, and finally the treatment of compound fractures.

Treatment of Simple Fractures.—Fractures are often met with at a distance from home, and in localities where no surgical appliances are at hand, and where no treatment can be satisfactorily carried out. Under such circumstances, it becomes necessary for the surgeon to attend, in the first place, to the *transportation* of his patient. If the fracture be in the upper extremity, it may be sufficient to support the injured limb in a broad sling made from handkerchiefs, when the patient can ride or even walk a short distance without much inconvenience; if the fracture be in the lower extremity, it will be necessary for the patient to be carried upon a sofa, or litter extemporized from boards, a window-shutter, etc. If a mattress cannot be obtained, the patient's head and the broken limb may be supported on any old cloths that can be procured, or upon straw. Temporary splints may sometimes be formed from the bark of trees, or made by laying together three or four thicknesses of folded straw or rushes. The limb should be laid in as easy a position as possible, and the litter borne deliberately, but with a firm step; it is usually recommended that the bearers should be instructed to step off with alternate feet, as it is said that thus less vibration is communicated to the litter. Before the patient is removed from the litter, the surgeon should see that a suitable bed has been prepared. Various *fracture-beds* have been invented by surgeons, amongst the most ingenious being those of Daniels, Burges, Coates, and Hewson, but, for practical purposes, I know of nothing better than a simple perforated hard mattress, with a pad accurately fitting the perforation, and a pan which slides in a frame-work beneath a corresponding opening in the bedstead; the latter should be provided with strong wooden or metallic slats, so as to furnish an even surface and secure firmness and rigidity to the whole arrangement. The lower sheet must, of course, be also perforated, and should be secured to the mattress so as not to form ridges under the patient's body. If a fracture-bed cannot be procured, an ordinary bedstead with a hard mattress may be used, in which case a bed-pan must be employed to receive the fecal evacuations.

These preliminary matters having been attended to, and the patient being in bed (if the fracture be in the lower extremity), the surgeon removes the clothing as gently as possible, and exposes the injured part and the corresponding part of the opposite side. He then, by a careful and methodical examination, proceeds to satisfy himself as to the nature and extent of the injury, and then, replacing the limb in an easy position, prepares his splints and bandages before attempting to reduce the fracture.

1. *Reduction, or Setting the Fracture*, consists in replacing the fragments by manipulation as nearly as possible in their normal position, as regards each other. I say advisedly, "as nearly as possible," for I believe with Prof. Hamilton, that it is only in exceptional cases that the displacement of fracture can be entirely overcome. Reduction should be effected *as soon as possible*, for the reason that it is much easier to the surgeon, and much less painful to the patient, if done before the development of inflammation; if, however, the patient is not seen until a later period, or if displacement should, from any cause, have recurred, the surgeon need not hesitate at any stage of the case to effect as perfect reduction as he can, for the slight additional irritation thus produced will be of much less consequence than the evils which would result from continued displacement. Reduction should

be effected *by the hands alone;* no mechanical contrivance should be used to give increased force, lest serious mischief to the already lacerated tissues should be produced. In the immense majority of cases, little or no force will be required, it being sufficient to place the limb in such a position as to relax the displacing muscles, when the bones will fall into position of themselves. Even in fracture of the femur, in which extension is commonly necessary to effect reduction, it is a good rule that no more force should be used than can be applied with the hands alone. In cases in which one or both fragments are embedded in the muscular tissue, or in which, from any other cause, there is great muscular resistance, it may be justifiable to employ anæsthesia as an aid to reduction.

2. *To Prevent the Recurrence of Displacement,* the surgeon makes use of various forms of apparatus, splints, bandages, etc. It is often very difficult to maintain reduction during the first few days, on account of the spasmodic action of the muscles constantly reproducing the deformity; but the tendency to spasm gradually passes off, so that by constant attention and careful dressing during the early stage of the treatment, it is almost always possible to obtain such accurate apposition of the fragments, as will secure a well-shaped and useful limb, though probably not one absolutely free from deformity. The different forms of bandage used by surgeons, and their modes of application, were considered in the chapter on Minor Surgery; the splints and special apparatus employed, will be described in discussing fractures of the several bones. Suffice it to say here, that the surgeon should aim to use as simple apparatus as possible; plain and light splints of wood, pasteboard, wires,[1] or thin metal, such as can be made by any carpenter or blacksmith, are, I think, in every way preferable to the elaborate and complicated appliances which have been, from time to time, recommended for the treatment of fractures. Straight and angular splints, made of smooth half-inch boards, for the upper extremity, straight splints and plain fracture-boxes with soft pillows for the lower extremity, a roll of cotton wadding or of tow for padding splints, or bags filled with bran or sand for the same purpose, a few pieces of binders' board, a half dozen or a dozen roller bandages, a few yards of adhesive plaster, and two or three bricks for use in making "weight extension," constitute an armamentarium sufficient for the treatment of almost all cases of fracture. The general principles to be observed in the use of splints and other apparatus may be stated as follows:

(1.) They are to be used as means of *retention only,* not of *reduction or extension;* these are effected by the surgeon's hands, and splints and bandages are merely to prevent the recurrence of displacement.

(2.) All splints, etc., should be *firmly and evenly padded,* so as not to exert injurious pressure on the bony prominences with which they come in contact, while at the same time the padding must not be so bulky as to render the splints clumsy or unmanageable.

(3.) *Circular compression* is to be carefully avoided, as swelling is inevitable after a fracture, and the risk of gangrene from this cause is by no means only theoretical. Hence, as a rule, in the early stages of fracture, *no bandage should be applied beneath the splints.*

(4.) In treating fractures of the shaft of a bone, the *nearest joints above and below* should, if practicable, be fixed by the splints used; if the fracture involve an articulation, the shafts of the bones which form the joint should themselves be so fixed.

(5.) When a fracture is properly "put up," unless the patient suffer so much pain as to render it probable that displacement has recurred, or that the splints are pressing unevenly, the dressing should not be disturbed more than absolutely necessary. It is a good rule to leave the fingers or toes exposed, so that the surgeon can by them judge of the condition of the circulation in the injured limb; and if they appear unduly congested or swollen, the dressings should be at once removed, and reapplied with additional precautions against gangrene. If a case do well, every other day is quite often enough to renew the bandages during the first fortnight, the interval between the dressings being gradually lengthened after that time to half a week, and finally to a week. At the same time, while in no class of cases is meddlesome surgery to be more reprobated than in this, fractures should be invariably looked upon as cases requiring careful and continual watching, and a patient with a broken bone should receive from his surgeon at least daily visits, until after the subsidence of all inflammatory symptoms.

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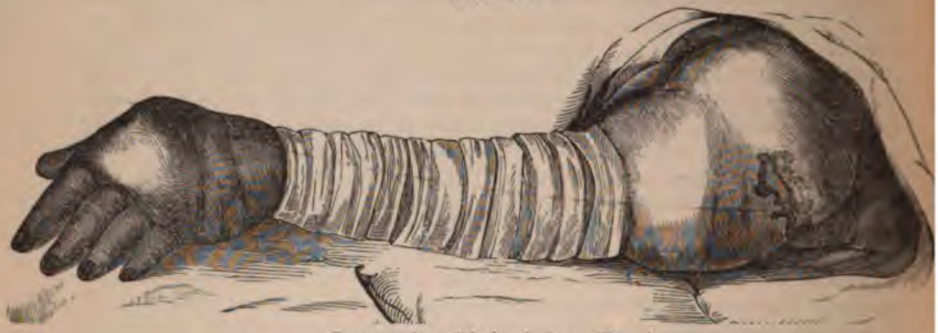
[1] Surgeon-Major Porter, of the Medical School at Netley, suggests that, in military practice, splints might be readily made from abandoned telegraph wire.

3. The third indication for treatment (see p. 226) brings up the consideration of the various accidents which may arise during the management of a case of fracture. *Muscular spasm* and *extravasation* are such constant accompaniments of fracture, as to entitle them to be considered as symptoms, under which head they have been referred to. *Spasm* is best controlled by the free use of opium; moderate compression with a firm bandage is often recommended, but is a somewhat hazardous remedy, and should be used with great caution. Tenotomy has been also proposed for this purpose; but I can scarcely conceive of a case in which its use would be justifiable. *Extravasation*, if moderate, may be disregarded; if there be much *contusion* and *vesication*, the limb should be simply laid on a pillow, protected by oil-cloth, while evaporating lotions are applied until the subsidence of inflammation; if large vesicles or bullæ form, they should be opened with the point of a lancet. If the extravasation proceed from the *rupture of a large artery*, the case will require special treatment, which will be considered under the head of complications. *Embolism* by particles of fat is an occasional complication of simple fracture, which has been already referred to at page 138.

Gangrene is the most serious accident which can be met with in the treatment of a simple fracture, and may be due either to arterial obstruction at a point above the seat of fracture, to venous obstruction due to swelling of the part or to tight bandaging, or to a combination of these causes. With regard to tight bandaging, it is to be remembered that a bandage may seem sufficiently loose when applied, and yet in a few hours may become the cause of great constriction from subsequent swelling of the limb; hence the importance of *not applying a bandage beneath the splints;* it is, as remarked by Mr. Erichsen, almost invariably to a neglect of this rule that the occurrence of gangrene from the pressure of a bandage is due. Especially is this true in the case of the forearm, in fracture of which part this accident most often occurs. It should not be forgotten, however, that this accident may be partly or entirely due to arterial obstruction, which is, of course, an unavoidable occurrence; hence we should not be too hasty in accusing a fellow-practitioner of malpractice on account of such an accident, for it may be really due, at least in some measure, to causes entirely beyond control. The *treatment* of gangrene occurring under such circumstances must vary according to its nature and extent; if it be due to constriction, and the surgeon fortunately discover it in time, he must instantly remove the bandages, when possibly the patient may escape with superficial sloughing. If complete gangrene have occurred, amputation, of course, becomes necessary; if the disease show a disposition to self-limitation, the surgeon may await the formation of the lines of demarcation and separation; but if the gangrene be of the rapidly spreading traumatic variety (p. 149), immediate removal of the limb must be practised at a point above the furthest limits of the disease. In the former case a favorable result may be anticipated, but under the latter circumstances the patient is apt to sink after the operation, as happened in a case in which some years since I amputated at the shoulder-joint, for spreading gangrene following a badly treated fracture of the forearm.

FIG. 108.



Gangrene from tight bandaging (BELL.)

The other accidents which occur during the treatment of fractures, cannot be considered as peculiar to these injuries. Thus there may be excessive inflammation, followed by abscess or sloughing, surgical fever, traumatic delirium, tetanus, erysipelas, or pyæmia. In old persons the confinement to bed required in the ordinary treatment of fractures may produce pulmonary or cerebral congestion; hence the advantage in such cases of using the plaster-of-Paris bandage or other immovable apparatus, which may enable the patient to get about as soon as possible.

In renewing the dressings of a fracture, the limb should be firmly and carefully held by an assistant, so as to prevent any recurrence of displacement while the splints are off; it is well at each dressing to gently rub the affected limb with soap liniment or dilute alcohol (carefully drying the part afterwards), so as to keep the skin in a healthy state. The patient's general condition should be attended to, and any disorder of the bowels or chest remedied by appropriate measures. The use of the catheter is very often required for a few days, when the patient is confined to bed, especially if the fracture be situated in the pelvis or femur.

Passive Motion is effected by the surgeon flexing and extending the joints of the injured limb, while firmly holding the parts above and below. There is a difference of opinion as to the time at which passive motion (which is designed to prevent anchylosis) should be begun; my own conviction is very clear that it should not be practised until firm union has occurred between the fragments—usually, therefore, not before the third or fourth week after the accident, and that it should even then be used with moderation and with gentleness. The patient may, indeed, often be safely left to regain mobility of the joints by the ordinary physiological exercise of the limb, assisted by methodical friction, and the use of the cold douche. In the case of the upper extremity, the patient may, after recovery, be advantageously directed to swing a flat-iron or put up a dumb-bell with the affected member, several times a day, continuing the exercise on each occasion until slight fatigue is experienced.

Treatment of Complicated Fractures.—Fractures may be complicated by various conditions which will require special modifications of the general course of treatment above described. Thus the extravasation, although proceeding from vessels of moderate size, may produce so much swelling as to give rise to great congestion or even strangulation of the tissues, and consequent gangrene, demanding amputation; or the contusion and subsequent inflammation may be so great as to cause suppuration and sloughing, resulting in the conversion of the case from one of simple, into one of compound fracture.

Rupture of the Main Artery of a limb is a very serious complication of fracture. This accident is principally met with in connection with fracture about the knee-joint, and the injured vessel may be either the posterior tibial or the popliteal. In either case, a rapidly increasing, obscurely pulsating tumor—a diffuse traumatic aneurism in fact—forms in the ham; and, unless promptly treated, will inevitably cause gangrene. If the *posterior tibial* be the wounded artery, at least partial warmth will be restored to the leg and foot, and pulsation will return in the anterior tibial: under these favorable circumstances, an effort should be made to save the limb by resorting to compression or ligation of the superficial femoral, in Scarpa's space. The reason for not treating the case as one of ordinary wounded artery is, that by so doing, even if the opening in the vessel could be found, which would be doubtful, the injury would be converted into a compound fracture of the worst kind, which would almost inevitably require amputation; while there would be a chance, though not a very brilliant one, that by the use of the proximal ligature, the arterial wound might heal, and allow the preservation of the limb. If, however, the temperature of the leg and foot continue to sink, and no pulsation can be detected in the anterior tibial, gangrene appearing imminent, it becomes almost certain that the *popliteal artery* is ruptured; and, under such circumstances, amputation should be at once performed. So, also, if after an attempt to save the limb gangrene should occur, amputation would be necessary. In any case of doubt, I think the safety of the patient would be consulted rather by removing the limb, while he was yet in good general condition, and when the operation could be done immediately above the knee, than by running the risk of being compelled to amputate at a higher point, with the patient under the depressing influence of gangrene. Dr. Laurent, a French surgeon, has collected 27 cases of this form of injury, occurring in various parts of the body, nine, or one-third of the cases, having terminated fatally. More favorable results were obtained by compression and ligation according to the Hunterian method than by other modes of treatment.

Rupture or other Serious Injury of an Important Nerve, as the musculo-spiral or median, is a very troublesome and annoying complication of fracture, causing loss of power or permanent impairment of the nutrition of the limb, as in a number of cases collected by Callender. This accident may not be apparent at the time of reception of the injury, and I have even known a surgeon to treat a broken arm until complete union of the fracture had occurred, not discovering the existence of paralysis until the splints were finally removed, when the limb dropped helplessly by the patient's side. The treatment of such a case is not very satisfactory; it should be conducted on the principles laid down in the last chapter, in discussing injuries of the nerves in general.

A very Severe Flesh Wound, even if not communicating with the seat of fracture and thus rendering it compound, may seriously complicate the progress of the case, and may occasionally necessitate amputation, Unless, however, the injury to the soft tissues were, in such a case, in itself sufficient to condemn the limb, a fair trial should always be given to conservative treatment before resorting to amputation.

The Implication of a Joint in the line of fracture, will very often give rise to a certain amount of stiffness, if not to absolute anchylosis, after recovery; or, in a strumous constitution, may cause disorganization of the articulation, and thus eventually render amputation imperative. In every case of fracture involving a joint, the treatment should be conducted with great caution, and the prognosis should be extremely guarded.

Dislocation of an Adjoining Articulation is a not unfrequent complication of fracture. In such a contingency the fracture should be temporarily put up with wooden splints and firm bandages, so that the limb may be used as a lever in effecting reduction of the dislocation, the patient being, of course, etherized. The fracture is then to be treated in the ordinary manner. If the dislocation be not recognized until a later period of the case, the surgeon must wait until firm union of the fracture has occurred, and then, applying splints, make an effort to reduce the dislocation, a feat which, under these circumstances, may be very difficult to accomplish.

A fracture in a limb which is the seat of an old *Unreduced Dislocation*, or of a *Previously Anchylosed Joint*, presents no peculiar difficulties of treatment, though it may require a modification in the form of the splints used, to adapt them to the existing deformity of the part.

Fracture of the bone in a *Stump*, or into the site of a *Previously Excised Joint*, is occasionally met with, but requires no special treatment beyond the necessary modification of apparatus.

Chorea, affecting a limb which is the seat of fracture, is a very serious complication: in a case of simple fracture of the humerus complicated with chorea, reported by Dr. Wm. Hunt, of this city, it was found impossible to keep the parts at rest, and the patient died exhausted on the tenth day.

A fracture occurring in a *Previously Paralyzed Limb*, commonly unites without particular difficulty. There is, of course, no risk of recurring displacement from muscular action, but special care must be taken to avoid undue pressure, which might readily induce sloughing.

Treatment of Compound Fractures.—The first question to be determined with regard to any case of compound fracture, is whether or not amputation is to be performed; if the operation is to be done at all, it should be done as soon as possible, for the reasons already given in Chapter V. If amputation have not been done before the setting in of the intermediate or inflammatory stage, it must be, if possible, further postponed until suppuration is freely established.

Amputation for Compound Fracture.—No universal rules can be laid down, as to what cases of compound fracture should be submitted to primary amputation, but each individual case must be treated on its own merits, according to the judgment of the surgeon. It may, however, be said that the circumstances which usually call for amputation in these cases are the following:

1. *Extensive and severe laceration of the muscular and other soft tissues.*—A compound fracture, in which the wound is made by the fracturing force, is a more serious injury than one in which the wound is made by the fragments perforating the skin, for the reason that in the latter case the soft tissues are comparatively little injured, while in the former they are apt to be greatly torn and bruised, or perhaps completely pulpefied. Hence compound fractures from railway and machinery accidents, especially in the *lower extremity*, are almost invariably cases for amputation; in the *upper extremity* it is often possible to save the limb, even in these unfavorable circumstances, and if the age and general condition of the patient should justify the attempt, it should certainly be made. It is in such cases that irrigation is found to be of special service in moderating the consecutive inflammation.

2. *A compound fracture accompanied with a wound of a large artery* will

often require amputation. If the bleeding vessel can be readily found and tied in the wound, or can be controlled by position, pressure, etc., this should be done, when, if other circumstances are favorable, an attempt may be made to save the limb. If, however, the wounded vessel cannot easily be secured, and if the part injured be the lower extremity, immediate amputation should be unhesitatingly resorted to. In the upper extremity such extreme measures may not be required, and if the bleeding vessel can neither be controlled by pressure, etc., nor secured in the wound, a ligature may be applied to the brachial artery, which has been several times successfully tied under such circumstances.

3. *Great comminution of the bones themselves* may be a cause for amputation in cases of compound fracture. In the upper extremity much may be done in the way of conservatism, by removing splinters, and then placing the bones in such a position as to favor union. In the lower extremity, if the comminution be so extensive that removal of the primary and secondary sequestra will leave a gap in the continuity of the bone, the resulting limb, even if it could be preserved, would scarcely have sufficient firmness to be useful, and hence in such cases primary amputation is to be recommended. An exception should, perhaps, be made in cases of compound fracture in the upper third of the thigh, in which position primary amputation is so fatal an operation that the surgeon is loath to resort to it under any circumstances; but, indeed, these injuries are very apt to terminate in death under any mode of treatment.

4. *Compound fractures into large joints* often require amputation. In the case of the shoulder or elbow, provided that the extent of bone lesion, or of laceration of the soft tissues, be not too great, *excision* should be practised in preference to removal of the limb. The hip-joint is so deeply seated that it is seldom involved in a compound fracture, unless from gunshot wound, or from some crushing injury which necessarily proves fatal from visceral complication; when the accident does occur, however, primary excision is, I think, the correct mode of treatment, and it has been successfully employed, under these circumstances, by P. A. Harris, of New Jersey. Compound fractures of the wrist, ankle, and knee-joints are usually cases for amputation. Especially should this rule be considered imperative as regards the knee-joint; much as I admire the operation of excision, and strenuously as I would advocate the practice of conservative surgery, I cannot but believe that in the immense majority of instances the best interests of the patient will be promoted by primary amputation in cases of compound fracture of the knee-joint.

5. A compound fracture, which would of itself require amputation, may be complicated by the existence of a *simple fracture in the same limb, but at a higher point.* In such a case, should the amputation be done at the seat of the upper fracture, or below? In my own experience, such cases, when an attempt has been made to save the limb, have invariably terminated fatally; hence, I should be disposed (unless the upper fracture were situated high up in the thigh) to recommend primary amputation, at or above the seat of highest lesion. Still, if it were certain that the soft parts between the two fractures were healthy, and quite free from injury, it might be right to remove only the part that was irretrievably hurt, and to make an attempt to save the rest of the limb; as it happens, however, these cases are usually such as result from accident by railway or other vehicles, or by machinery, and are apt to be attended with much greater destruction of soft parts than is at first apparent; so that, in most instances, amputation at the highest point of injury will be found the safest mode of treatment.

The complication of compound fracture with *dislocation at a higher point* *of the same limb*, is of less consequence. In such a case the broken bones should be temporarily put up, and the dislocation reduced, the compound fracture being afterwards treated on its own merits.

Compound epiphyseal separation is sometimes met with in young persons, and may be mistaken for compound fracture involving an articulation, from which lesion it can, however, always be distinguished by careful examination. If, as sometimes happens, the diaphysis project through the wound, reduction is very difficult, and can usually be accomplished only by resecting the projecting portion, an operation which may be best performed with Butcher's or a chain saw. The after-treatment does not differ from that of ordinary compound fracture; the resulting limb, though shortened, is not materially impaired in utility, even in the case of the lower extremity.

Treatment of Compound Fractures which do not require Amputation.—Many ingenious forms of special apparatus have been invented for the treatment of compound fractures, but I am not aware that they present any advantages over the ordinary splints and boxes habitually used in the management of simple fractures. The only special precaution to be observed is, to so arrange the splints and bandages that free drainage may be secured from the wound, and that the latter may be readily accessible without removing the entire apparatus.

The points to be particularly attended to in the treatment of these injuries are: 1. Reduction of the fracture. 2. Extraction of splinters. 3. Closure of the wound; and 4. Management of the consecutive inflammation.

1. *Reduction* is to be effected, as in the case of simple fracture, by relaxing the neighboring muscles, and by gentle manipulation. If a fragment project through the skin, the difficulty of reduction is much increased, and in such cases it may be necessary to enlarge the external wound, or even to resect the projecting end of bone. This measure should, however, be resorted to with extreme hesitation, especially in the lower extremity, for the loss of any considerable portion of the continuity of a long bone will be apt to result in the formation of a false joint, requiring subsequent amputation. This, indeed, has been the ordinary result in cases in which I have seen this operation performed.

2. In the management of *splinters or sequestra*, the rules which were given in the chapter on Gunshot Wounds, founded on Dupuytren's division of splinters into primary, secondary, and tertiary, are to be observed. Those fragments which are loose or but slightly connected are to be removed, while those which are more firmly attached are to be pushed into place, that they may give solidity to the callus, and assist in the repair of the injury. In case of doubt, it is better to err on the side of allowing fragments to remain, as, if they afterwards become necrosed, they will be spontaneously loosened, when they can usually be removed without much difficulty, though in some cases a dead splinter may become surrounded by callus, requiring division of the latter before the sequestrum can be extracted.

3. If the *external wound* be small, and unaccompanied with much contusion, an attempt should be make to close it, and thus convert the case into one of simple fracture. I have frequently succeeded in doing this; and the effort should always be made when the nature of the case will permit it. For this purpose the wound is to be washed and freed from blood, and then hermetically sealed with gauze and collodion, styptic colloid, Paresi's antiseptic preparation (page 147), or the compound tincture of benzoin; or, in the absence of these agents, simply with a piece of lint dipped in blood, as recommended by Sir Astley Cooper. If, however, the wound be a large one, or if it be accompanied with much contusion and laceration, it will be useless to attempt its closure, and it should then be dressed lightly, and in such a

way as to allow of free drainage. Even if an attempt have been made to close the wound, the parts should be frequently examined, and if it appear that pus is accumulating underneath the dressing, the latter should be immediately removed, and free vent given to the accumulated discharges.

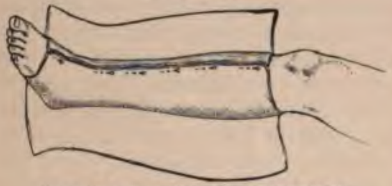
4. The management of the inevitable *consecutive inflammation* which attends compound fractures, is to be conducted in accordance with the principles enunciated and the rules laid down in the chapters on the Treatment of Inflammation, and on Wounds in General. Ice, water-dressing, irrigation, laudanum fomentations, poultices, astringent washes, antiseptic applications, etc., may each and all be appropriately used in different cases and under different circumstances. The splints employed should be protected by oiled silk from being soiled by the discharges; and while the fracture should not be unnecessarily disturbed, the utmost care must be taken to keep the parts clean, and to preserve the neighboring integument in a healthy condition. In compound fractures of the lower extremity, the *bran dressing*, introduced by Dr. J. Rhea Barton, of this city, will be found most serviceable. It affords equal pressure and support to the injured member, restrains hemorrhage, absorbs discharges, and can be daily renewed, as far as necessary, without material disturbance of the limb. Its mode of application will be described in the next chapter. The patient's general condition must also receive attention. The action of the bowels must be regulated, and traumatic fever moderated by the administration of suitable remedies. When suppuration is fairly established, tonics, especially iron, quinia, and cod-liver oil, may be freely exhibited. The diet should be nutritious, but unirritating; and in the later stages, or perhaps from the first, free stimulation may be required. The connection which has now been so often traced as to make it appear causal, between prolonged suppuration and the peculiar form of visceral degeneration known as *albuminous* or *amyloid*, clearly indicates the paramount importance, in these cases, of maintaining the patient's strength and supporting his system in every possible manner. The time required for the cure of a compound fracture may be estimated at from two to three times as long as would be needed in the case of a simple fracture of the same part.

Secondary amputation may be required in the treatment of compound fractures, on account of traumatic gangrene, sloughing following erysipelas, osteo-myelitis, extensive necrosis, general exhaustion of the patient, hectic, etc. The proper period for amputation in cases of traumatic gangrene has already been pointed out in preceding chapters. In the case of the other complications which have been mentioned, the surgeon must choose his time as best he can, operating at some period when there is a momentary subsidence of constitutional disturbance, and while not hastily condemning a limb without fair trial of conservative measures, yet not delaying interference until the patient has sunk so low that interference will be of no avail. The only general rule that can be given with regard to these cases, is, to avoid, if possible, operating during the *intermediate* stage, which usually ranges from the second to the tenth or twelfth day. After suppuration has been fairly established, the case becomes somewhat assimilated to one of chronic disease, and amputation can then be performed with comparatively fair prospects of success.

Treatment of Fractures with "Immovable Apparatus."—In the later stages of the treatment of fractures, advantage may often be derived from the use of a plaster-of-Paris bandage, or one of the other forms of immovable dressing described in Chapter IV. It is right to add that several excellent surgeons, both at home and abroad, recommend the use of these dressings even in the early stages of fractures, and believe that by their employment as good, if not better, results may be obtained than by the ordinary methods. For my own part, I cannot but regard any form of immovable dressing as unsafe, when employed before the swelling which always follows a fracture has entirely subsided, and I am not in the habit of applying the plaster bandage until the union of the broken bones has become tolerably firm—usually in the course of the third or fourth week. I would invite those who are interested in the further consideration of this subject to refer to Prof. Hamilton's excellent treatise, where the comparative advantages of these different modes of treatment are fully, and—as far as I am able to judge—very fairly, set forth.

There are two principal ways in which the plaster-of-Paris bandage may be applied; one, and that which I think upon the whole the best, consists in the application of the wetted gypsum roller over a dry roller, in the way described on page 83, care being taken to keep the limb well extended while the plaster is setting; and the other, or "Bavarian plan," in which two pieces of flannel, stitched together at their middle by a straight seam, are laid beneath the limb, the inner layer being then folded evenly around the part and secured with pins or stitches, when the liquid plaster is spread over it, and the outer layer finally brought up and secured in the same manner as the first; after the plaster has become hard, the pins or stitches are removed, when the splint may be opened and taken off, the seam at the back serving as a hinge.

FIG. 109.



Bavarian immovable splint. (BRYANT.)

Treatment of Badly United Fractures.—From various causes, over some of which the surgeon may have no control, a fracture may unite with so much deformity as to disfigure the limb, if not to render it useless. If the deformity be in a *longitudinal* direction, depending on overlapping of the fragments, the case is, I believe, hopeless, for the surrounding muscles will have probably become permanently contracted and shortened, and attempts at extension after union has once occurred will prove fruitless. *Transverse* deformity will be gradually lessened by the processes of nature, superfluous callus being absorbed, and projecting bony prominences rounded off. *Angular* deformity, if very slight, may be left to nature, in the hope that it will be gradually removed by the physiological action of the muscles. If at all marked, however, it will require treatment, and this, if the bony union be comparatively soft, can usually be satisfactorily carried out by careful bandaging and the judicious use of pads and compresses—or the surgeon may by gentle but firm pressure *bend* the newly-formed callus, so as to restore the limb to its proper shape. If the union of the fracture be further advanced, more force may be required, and the surgeon may *break* the bone over again, with a view to resetting it in a better position. This may be done with the hands, or at a later period with a screw clamp, such as those devised for the purpose by Rizzoli, Von Bruns, Butcher, and C. F. Taylor, of New York. A remarkable case has been reported by Mr. Switzer, an English army surgeon, in which a large amount of deformed callus disappeared under inunction with compound iodine ointment, and it would certainly be proper to try the sorbefacient effects of this remedy before resorting to the severer measures which will next be described. When the callus is so firm as to resist the application of such an amount of force as the surgeon deems justifiable, he may adopt measures to weaken the bond of union, by operative interference.

Perhaps the best plan in such a case is that suggested by Brainard, of Chicago, which consists in subcutaneously drilling through the uniting medium in various directions, and then rupturing the remainder; or the bone may be partially divided with a saw (Langenbeck) or chisel (Nüssbaum, O'Grady), or, as done by Warren and Heath, a wedge-shaped piece may be removed from the apex of the bony angle, the rest of the bond of union being, in either case, broken through, as in Brainard's method; or the deformed callus might be exsected, and the fragments firmly wired together—an operation which I have successfully resorted to in one instance, and which has also succeeded in the hands of Dr. Forbes, of this city, but which, in addition to its inherent risks, of course, exposes the patient to the chance of recovering with a false joint; or, finally, in an aggravated case, it might be necessary to resort to amputation. For further information on this subject, the reader is respectfully referred to Dr. G. W. Norris's excellent paper, in his well-known *Contributions to Practical Surgery*.

Reduction of Deformity in Partial, and in Impacted Fractures.—In connection with the subject of *Badly United Fractures*, I may refer to the question which often arises as to whether or no reduction should be attempted in cases of partial and of partially impacted fractures. The answer to this question may be said to depend upon the position of the fractured bone; thus, while it would be manifestly improper to attempt reduction of an impacted fracture of the neck of the femur, it is, I think, right to reduce a partial fracture of the clavicle or of the forearm, even at the risk of converting the case into one of complete fracture. In the forearm (and in the clavicle, if the angular projection be outwards), the deformity would be so great as to be very objectionable, while inward angular displacement of the clavicle might endanger the integrity of the important underlying structures by irritation from bony spiculæ.

Tardy or Delayed Union of Bones is occasionally met with, and is, probably, more often dependent on constitutional than on local causes. Sometimes it appears to result from mere debility and depression, without the existence of any positive cachexia; under such circumstances it may be sufficient to get the patient out of bed, with his limb supported in a plaster-of-Paris bandage, letting him recover his health by means of out-door exercise. In some cases the process of union may be assisted by the use of tonics, especially cod-liver oil and the phosphates (which, however, have not been found as practically useful as was anticipated), and by giving an extra allowance of ale or porter. If a syphilitic taint be suspected, iodide of potassium or mercury may be cautiously administered.

UNUNITED FRACTURE AND FALSE JOINT.

Occasionally a broken bone does not unite at all, or unites only through the medium of fibrous or ligamentous bands, or, having been united, becomes again separated by the absorption and softening of the callus. In some bones, indeed, as in the patella, bony union almost never occurs, but in such cases the want of union cannot be considered abnormal. The terms *ununited fracture* and *false joint* are applied only to fractures in those situations in which bony union is habitually met with, as in the various long bones, or the lower jaw. The *proportion* of cases in which non-union occurs is estimated by Hamilton at 1 in 500; it is, therefore, a rare accident.

Dr. Norris, of this city, whose monograph on this subject is the best that has yet been published, has described four distinct forms under which non-union of fracture may occur. The *first* is that which has already been referred to under the name of *delayed union;* here callus is formed, but does not undergo complete ossification, and, hence, the union is imperfect. "In the *second* class of cases, there is entire want of union of any sort between the fragments, the ends of which seem to be diminished in size, and are extremely movable between the integuments. The limb in these cases is found greatly shrunken, and hangs perfectly useless."[1] In the *third* and most usual form, the ends of bone are rounded off and tapering, and "are connected together by strong ligamentous or fibro-ligamentous bands," passing between the fractured extremities; there may be but one band, or several; "in either case the newly-formed substance is firmly adherent to the bones, and, if of any length, is in a high degree pliable." In the *fourth* variety, to which the name of *pseudarthrosis* or *false joint* is properly given, "a dense capsule without opening of any sort, containing a fluid similar to synovia, and resembling closely the complete capsular ligaments, is found. In these cases the points of the bony fragments corresponding to each other are rounded, smooth, and polished, in some instances are eburnated, and in others are covered with points or even thin plates of cartilage, and a membrane closely resembling the synovial of the natural articulations. It is in this kind of cases that the member affected may still be of some utility to the patient, the fragments being so firmly held together as to be displaced only upon the application of considerable force.

The *diagnosis* of ununited fracture is usually sufficiently easy: I have, however, known great relaxation of the ligaments of the wrist-joint to be mistaken for ununited fracture of the extremity of the ulna.

Causes of Non-union after Fracture.—These may be either constitutional or local. Among the former may be enumerated general impairment of health, and various cachectic conditions and diatheses, such as scurvy, phthisis, rickets, syphilis, or cancer. With regard to the influence of cancer in preventing union after fractures, Dr. Norris says that when the accident depends upon the presence of a cancerous tumor at the seat of fracture, union will not occur, but when it depends on mere brittleness, resulting from what Mr. Curling has called eccentric atrophy, the bones unite readily enough. So with regard to syphilis and rickets; though cases are recorded in which these appear to have acted as causes of non-union, other cases are frequently met with in which the disease is well marked, and yet union readily occurs. *Pregnancy* is often regarded as a cause of non-union in fractures, but it is probably thus effective in those cases only in which the pregnant state is accompanied by great debility, as from sympathetic vomiting. The same remark applies to the supposed efficiency of *lactation* as a cause of ununited fracture. *Age* does not appear to exert any particular influence, fractures in the very young and the very old often uniting quite as well as in those of middle life, and more than one-third of the whole number of cases of ununited fracture occurring in those between twenty and thirty. Among the more prominent *local causes,* may be mentioned deficient vascular or nervous supply, mobility or want of proper apposition of the fragments, the intervention between the fragments of a shred of muscle or other soft tissue, or of a foreign body, necrosis or other disease of the ends of the fragments themselves, injudicious treatment (especially tight bandaging and prolonged use of cooling applications), and too early use of the fractured limb. The frequency with which ununited fracture occurs in different parts, is shown in the following table taken from Dr. Norris's paper.

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[1] Dr. C. B. Porter, of Boston, reports a case in which after ununited fracture the humerus was absorbed, and entirely disappeared without exfoliation.

Locality.	Number of cases.	Cured.	No benefit.	Died.	Result unknown.
Thigh,	48	31	9	6	2
Leg,	33	32	1	...	...
Arm,	48	31	14	3	...
Forearm,	19	17	1	1	...
Jaw,	2	2	...	...	...
Total,	150	113	25	10	2

Ununited fracture is also occasionally met with in the clavicle, scapula, ribs, and spine.

Treatment.—The treatment of ununited fracture, and of false joint, consists in removing, as far as possible, by constitutional, hygienic, and local measures, any cause which may seem to hinder the process of union between the broken bones, and in endeavoring to excite in the periosteum, in the medulla, and in the fragments themselves, such activity as will induce those changes which we have seen to be necessary in the natural process of repair after fracture. For this purpose, those remedies should be employed which were spoken of in treating of *delayed union*, the fragments being accurately adjusted, and rendered perfectly immovable by the use of suitable splints and bandages. Firm and accurately-fitting splints of metal, leather, or pasteboard may be employed, or the plaster-of-Paris bandage,[1] or (in the case of the lower extremity) the ingenious and elegant contrivances of Prof. Smith, of this city, or of Dr. Hudson, of New York. In order to excite renewed activity in the periosteum and other bone-producing tissues, various plans, such as blistering, cauterizing, or galvanizing the skin, have been employed, and when the beneficial effect of *transmitted* periosteal and medullary irritation is remembered, it can readily be understood that these methods should occasionally have proved successful. Other plans which have sometimes succeeded, consist in rubbing together the ends of the fragments themselves, and in "percussing" the injured limb with a rubber-protected mallet (Thomas). In the event of these simple remedies failing, severer measures may be employed: of these the most important are the establishment of a seton between the fragments, as recommended by Dr. Physick, or on either side of the ununited fracture, as suggested by Oppenheim; the introduction of *stimulating injections*, as practised by Hulse, Bourguet, and Fitzgerald; *acupuncture*, as suggested by Malgaigne; the introduction of *ivory pegs* (Dieffenbach and Hill); *electro-puncture* (Lente); *subcutaneous scarification* (Miller); *drilling the fragments themselves* (Detmold and Brainard); *scraping or cauterizing the fragments*; holding the fragments together by means of *sutures or pins* (Severinus, Rodgers, Gaillard, and F. Mason); *resection* (White, Roux, Jordan, and Bigelow); covering in the false-joint with *periosteal flaps* inverted from the bone above and below (Rydygier); *transplantation* of fragments split off from a neighboring bone (Nüssbaum), or from bones of other patients (MacEwen), or of dogs (Patterson); and finally *amputation*. Of all these, the most promising methods are, I think, those of Physick, Brainard, Gaillard, and Bigelow. Before resorting to any of them, the suggestion of Ollier may be adopted, to rejuvenate, as it were, the periosteum by the milder forms of irritation, that it may afterwards more readily respond to the severer operation. Physick introduced a piece of silk or tape, by means of a long seton needle, directly between the fragments, and allowed the foreign body to remain four or five months. Norris has, however, shown that the seton is equally efficient and more safe when removed at an earlier period, and surgeons now seldom allow it to remain longer than a fortnight; it is rarely used in the case of the thigh, where other means are more successful. Brainard's plan consists in drilling the fragments subcutaneously with a metallic perforator or bone drill. His manner of using the instrument, as quoted by Hamilton, is as follows: "In case of an oblique fracture, or one with overlapping, the skin is perforated with the instrument at such a point as to enable it to be carried through the ends of the fragments, to wound their surfaces, and to transfix whatever tissue may be placed between them. After having transfixed them in one direction, it is withdrawn from the bone, but not from the skin, its direction changed, and another perforation made, and this operation is repeated as often as may be desired." Prof. Gaillard's method consists in pinning together the fragments by means of a gimlet-like instrument, provided with a movable silver sheath, a handle, and a brass nut (Fig. 111): the sheath is introduced through an incision, and held against the bone, while the shaft is passed through and made to transfix both fragments; the nut is then screwed down firmly on the sheath, the whole instrument being allowed to remain *in situ* till union is obtained. This plan affords more secure apposition than merely wiring together the fragments, as practised by Rodgers, Flaubert, N. R. Smith, and others. The operation employed by Prof. Bige-

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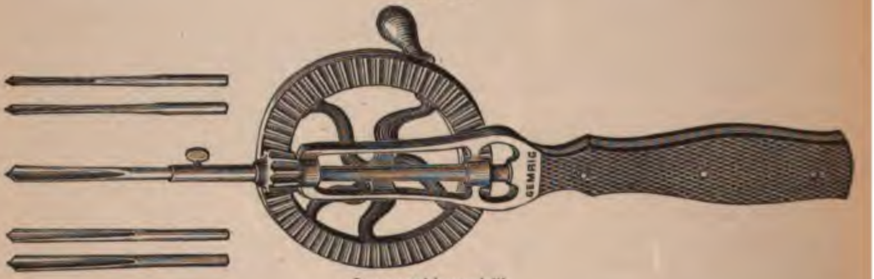
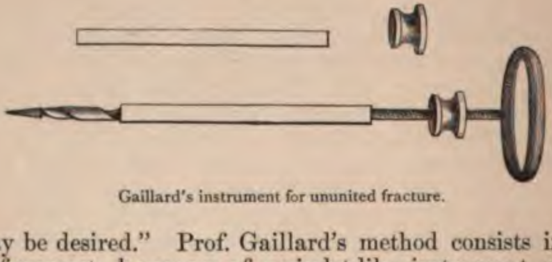
[1] Guenther, a Danish surgeon, and Nillien, of Illinois, have observed that the growth of the nails is arrested during the early stages of a fracture, to be resumed as the process of repair goes on, and they suggest this as a means of testing the progress of cure, without disturbing the dressings, in cases of delayed union, or of false joint. It would appear, however, that the growth of the nails may be checked by any cause which interferes with the nutrition of the part, and hence this test might not be universally applicable; Mitchell has noticed an arrest of nail growth in cases of cerebral paralysis, and Gay has observed the same phenomenon as a result of compression of the subclavian artery.

FIG. 110.



Improved bone-drill.

FIG. 111.



Gaillard's instrument for ununited fracture.

low, of Boston, is almost identical with that independently suggested by Ollier, of Lyons, and is probably the surest method of treating ununited fracture; it consists in making a *subperiosteal resection* of the ends of the fragments, the freshened extremities being then held together by a wire suture. Dr. Bigelow has thus treated eleven cases, with but one failure, and that from disease of the bone, which subsequently required amputation. This plan has also been successfully adopted by other surgeons, including Byrd, of Illinois, Annandale, Packard, and myself.

Whatever method be employed, the after-treatment must be carefully conducted by the use of proper splints, and by the administration of tonics and good food. The phosphate of lime is recommended by Bigelow and Dolbeau, the latter of whom finds that the action of the drug is manifested by the occurrence of formication in the injured limb. In some cases, when the inconvenience resulting from the ununited fracture is not very great, it might be advisable to decline any operation, and employ the apparatus of Prof. Smith, already referred to, or some similar contrivance.

CHAPTER XII.

SPECIAL FRACTURES.

I HAVE gone so fully, in the last chapter, into the consideration of the causes and symptoms of fractures in general, and of the principles by which the surgeon should be guided in undertaking their treatment, that it will not be necessary to repeat what has been said, with regard to each several bone; hence, in the present chapter, I purpose merely to point out the peculiar symptoms and diagnostic marks of the special fractures, and to indicate very briefly the most convenient and satisfactory modes of treatment, referring the reader, for more detailed information upon this subject, to the excellent treatises of Hamilton, Malgaigne, Cooper, Smith (of Dublin), Lonsdale, etc., and to the chapter on Fractures in Dr. Wales's valuable work on *Mechanical Therapeutics*, which contains a very good account of the different forms of apparatus devised for the treatment of broken bones. Fractures of the skull, and of the vertebræ, are principally interesting on account of their involving respectively the brain and spinal cord; hence their consideration will be postponed till we come to speak of injuries of those parts of the body.

FRACTURES OF THE FACE.

Any of the facial bones may be broken by direct violence, and especially by gunshot wound; the nature of the injury is usually recognized with facility, and the treatment should be particularly directed to the lesion of the soft tissues.

Nasal Bones.—These are not unfrequently broken, and the injury may escape detection from the rapid swelling of the soft parts. The treatment consists in removing the displacement (if there be any), by inserting a broad director or a pair of polypus forceps into the nostrils, and *moulding* the bones into their proper places; the parts may then be supported by means of a compress on either side, and a few strips of adhesive plaster, or, as suggested by L. D. Mason, of Brooklyn, by passing a pin beneath the bones so as to keep them in position. If the *septum* be broken, it should be restored to its proper place in the same way, the shape of the nose being preserved by plugging the nostrils, if necessary. Occasionally the whole nose is split off, as it were, from the face, hanging by the alæ in front of the mouth. In such a case, in which the injury was produced by a blow from an iron pan, I kept the nose in place by numerous sutures, the patient making a good recovery. Sometimes the whole nose is driven inwards, fracturing the ethmoid bone, and involving the brain. Under such circumstances, the nose should be gently drawn forwards with forceps, and the case treated as one of fracture at the base of the skull. Profuse hemorrhage may require plugging of the nares. W. Adams and R. F. Weir have devised special apparatus for forcibly straightening the nose when deformity has ensued, and for subsequently keeping the parts in position. An ingenious nasal splint has also been devised by Gamgee, of Birmingham.

Fracture of the Lachrymal Bone may cause obstruction of the nasal duct, and consequent epiphora; or emphysema of the subcutaneous tissue may follow whenever the patient blows his nose.

Fracture of the Malar Bone is to be treated by keeping the parts in place by compresses, adhesive strips, and bandages.

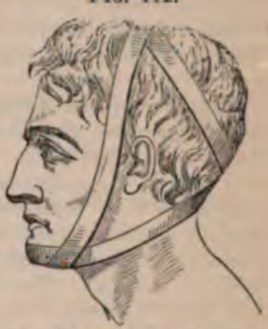
Fracture of the Zygoma, if comminuted, may interfere with mastication, by the impaction of splinters in the temporal muscle; in such a case, the surgeon should cut down and remove the offending fragments.

Upper Maxilla.—Fractures of the upper jaw are sometimes attended with such profuse hemorrhage as to require plugging the antrum, or even ligation of the external carotid. If the malar bone be thrust in upon the antrum, it should be drawn out with a *tirefond*, or screw elevator (Fig. 78), aided by pressure from within the mouth. If the upper jaw be broken through the alveolus, the teeth may be held together by means of wire. The vascular supply is so free in this part, that necrosis rarely follows, even in cases of gunshot injury; the fetid discharge is, however, a source not only of annoyance, but of constitutional depression, and hence free use should be made in such cases of detergent and disinfectant washes. Sometimes all the bones of the face are crushed and separated from their attachments by explosions, violent blows, or falls. Such cases are attended with great shock, and usually prove fatal from hemorrhage or cerebral complication.

Lower Maxilla.—The lower jaw is more frequently broken than any other bone in the face. The fracture, which is usually caused by direct violence, may be in any part of the bone, the most usual seats being, however, near the symphysis, and about the position of the mental fŏramen. The lower jaw is often broken in two or more places at once, and its fractures are frequently rendered compound by laceration of the mucous membrane. Fractures near the symphysis are more or less transverse, while those further back are almost invariably oblique from before backwards, allowing considerable displacement, which is evidenced by shortening of the alveolar border, and depression of the chin. In fractures near the angle of the bone, the dental nerve is occasionally involved, an accident which causes temporary paralysis, or more rarely convulsions. The displacement, mobility, and crepitus, which accompany fracture of the jaw, render its diagnosis usually easy: in cases of fracture below the condyle, there is, besides, embarrassment in the motions of the jaw, and pain, felt especially on opening or shutting the mouth. Fractures of the lower jaw commonly unite without much difficulty, and with little deformity.

Treatment.—For the treatment of an ordinary case of broken jaw, nothing is required except a compress to support the chin, and a roller bandage. Velpeau, indeed, during the last years of his life, is said to have abandoned all forms of apparatus, in the treatment of these injuries, believing that sufficient rest was insured to the fragments by the inevitable occurrence of pain upon any attempt at motion made by the patient. I am in the habit of treating these fractures in the manner recommended by Dr. J. Rhea Barton, of this city, with the superaddition of a few occipito-frontal turns of the roller, as in Gibson's bandage. The following description of Barton's bandage is taken from Sargent's minor surgery:—"*Composition:* A roller five yards long, and two inches wide; suitable compresses. *Application:* Place the initial extremity of the roller upon the occiput, just below its protuberance, and conduct the cylinder obliquely over the centre of the left parietal bone, to the top of the head; thence descend across the right temple and zygomatic arch, and pass beneath the chin," which should be supported by a compress, "to the side of the face; mount over the left zygoma and temple to the summit of the cranium, and rejoin the starting-point at the occiput, by traversing obliquely the right parietal bone; next, wind around the base of the lower jaw on the left side to the chin, and thence return to the occiput along the right side of the maxilla;" to these three turns, I add a fourth, around the head just above the ears, making an occipito-frontal turn, which being pinned at its intersection with the others, serves to prevent slipping. The same course is to be continued until the roller is exhausted, and additional security may be furnished by *sealing* the bandage (as it were) with a few strips of adhesive plaster. *Gibson's bandage* consists of a compress beneath the chin, with turns of a roller passing from that part to the top of the head, from the occiput to the forehead, and from the nape of the neck to above the mental protuberance, the whole being held in place by a short strip passing from the forehead, backwards to the nape along the median line of the head.

FIG. 112.



Barton's bandage for fractured jaw.

Many surgeons prefer to treat fractures of the jaw with an external splint, moulded from pasteboard or gutta-percha, and held in place by a simple sling of four tails, two of which are tied on the top of the head and two behind the neck (Fig. 15), or with an ingenious apparatus composed of a leathern sling, with strong linen webbing straps, devised for the treatment of these cases by Prof. Hamilton; *wiring* together the teeth on either side of the fracture is often recommended, but I confess to have seen very little advantage from the practice: a better plan is the application of *clasps* of ivory, silver, steel, or other material, as practised by Lonsdale, Mütter, N. R. Smith, Nicole, Wales, Bullock, and others, or of *interdental splints* of gutta-percha or vulcanized India-rubber, as ingeniously applied by Dr. Gunning, of New York, and Dr. Beans, of Atlanta, Ga. In a case of fracture of both rami of the jaw, Annandale succeeded in obtaining a good result by cutting down externally, on each side and securing the fragments by means of the *wire suture.* A similar plan, in cases of single fracture, had been previously employed by Buck and Hamilton, of New York, and by Kinloch, of Charleston, and I have myself adopted it with good results, when there has been much tendency to separation of the fragments.

Whatever mode of treatment be adopted, care must be taken not to produce uneven or undue pressure. Neglect of this precaution will cause great irritation, and probably the formation of abscess, a very troublesome and painful complication of fractured jaw, and one that may give rise to necrosis and to consequent non-union, which accident is, in this position, I believe, more apt to result from *tight* bandaging than from the bandage being too loose. *Gunshot fracture* of the lower jaw is sometimes attended with so much splintering as to require partial resection of the bone. The period required for the cure of a simple fracture of the jaw is usually from three to six weeks.

Fracture of the Hyoid Bone is a very rare accident. Hamilton has collected ten cases, of which three were caused by hanging, three by grasping the throat between the thumb and fingers, three by direct blows or falls, and one by muscular action. The accident is attended with great pain, sometimes with hemorrhage, and with difficulty in opening the mouth, in swallowing, and in speaking. The *diagnosis* can be made by observing the mobility of the fragments, and the inward angular displacement, with or without crepitus. The *treatment* consists in reducing the deformity, by pressure from within the mouth, and in keeping the parts at rest by use of a pasteboard or leather collar, with the enforcement of quiet, and the hypodermic administation of opium. Of thirteen cases collected by Dr. Gibb, two proved fatal.

Fractures of the Trunk.

Ribs.—The ribs are more frequently broken than any of the other bones of the trunk: these injuries may be produced by direct violence, as from the kick of a horse, or by indirect violence, the front and back of the chest being pressed together, and the ribs giving way like an over-bent bow, at the weakest part.[1] The ribs are occasionally broken by muscular action (as in parturition), or, according to Malgaigne, even by the impulse of the heart. The middle ribs, from the fourth to the tenth, are those most exposed to fracture, and the usual seats of injury are near the junction of the costal cartilages, and in the neighborhood of the angles. The direction of the fracture is commonly transverse or slightly oblique; occasionally a rib is comminuted, or broken in more than one place. These fractures are rarely compound, except as the result of gunshot wounds. The displacement in cases of fractured rib is usually slight; if the result of a direct blow, there will probably be some inward angular deformity, while if from indirect violence, the projection will be outwards; if a number of ribs on the same side be broken, there may be a slight tendency to overlapping. The *diagnostic* signs are deformity, mobility, and crepitus, which is sometimes readily perceived, but at other times can only be elicited by careful and prolonged manipulation, by compressing the chest from before backwards, or by auscultation. There are, besides, pain and localized tenderness, with a sharp *stitch*, if the pleura be wounded, and, possibly, hæmoptysis, pneumothorax, or emphysema, if the lung be involved. The pain is much increased by movements of the chest wall, and the breathing is therefore shallow, and to a great extent diaphragmatic. The *prognosis* is favorable; except in cases complicated with thoracic or other severe injury, it is very rare for death to follow fracture of the ribs. Union commonly takes place in from three to five weeks, with very little deformity, and by means of a well-marked ensheathing callus. False-joint is occasionally met with in this situation, while, on the other hand, the production of new bone is sometimes excessive, causing coalescence between adjacent ribs.

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[1] This is denied by E. H. Bennett, of Dublin, who has shown that impaction with splintering, and inward displacement, may result from indirect violence.

Treatment.—In the treatment of fractured ribs, the surgeon may disregard any existing deformity, which will usually spontaneously disappear by the expansion of the chest in the respiratory movements; even if it should not, it would be preferable to allow the displacement to remain, rather than to attempt its removal, as has been proposed, by the use of sharp hooks or screw elevators. The chief indication in any case of fractured rib, is to put the affected part in a state of complete rest, and this may best be done by surrounding the side of the chest which is involved, with numerous overlapping broad strips of adhesive plaster, each reaching a little beyond the median line, both behind and before. This mode of treatment, which appears to have originated with Dr. Hannay, of England, is, according to my experience, much superior to any other which has been proposed. The strips, which should be about two inches wide, are laid on in circular layers, beginning from below, each strip overlapping its predecessor by about one-third of its width. As the dressing becomes loosened, other layers of strips are to be tightly applied immediately over the first, so that the chest is kept constantly fixed by a stiff and firm splint of adhesive plaster. The patient will usually be most at ease in a sitting posture for the first day or two. Thoracic complications must be met by appropriate treatment, and in any case opium may be freely administered. The dressing may be removed at the end of three weeks, when union is commonly sufficiently firm to enable the surgeon to discontinue his attendance. If, in any case of injury of the chest, it is uncertain whether a rib be broken or not, the dressing above described should be applied, as it will afford great comfort, even in cases of contusion without fracture.

The *emphysema* which sometimes accompanies fracture of the ribs requires no special treatment, usually disappearing spontaneously in the course of a few days or weeks. *Rupture or laceration of an intercostal artery*, which proved fatal in a case recorded by Amesbury, could scarcely be recognized unless the fracture were compound. Under such circumstances an effort should be made to secure the bleeding vessel, for which purpose, if necessary, a portion of the adjacent rib might be excised. In cases of *gunshot fracture*, all spiculæ should be carefully removed, and the after-treatment conducted with reference to the condition of the thoracic viscera, on the principles which will be laid down in the chapter on Injuries of the Chest.

The *Costal Cartilages* are occasionally broken, either at their junction with the ribs or through their middle. The causes are the same as in the case of fractured ribs; but, as the violence required is greater, there is more apt to be serious visceral complication. The symptoms are the same as those of fractured ribs, except that crepitus is rarely perceptible. The direction of the fracture is commonly transverse, the anterior fragment usually projecting in front of the posterior. Union takes place by the production of *bone*, not of cartilage, the callus being chiefly developed on the pleural side of the fracture; non-union has been observed in one case by Hamilton. The treatment consists in the application of adhesive strips, as for fractured ribs.[1]

Sternum.—True fracture of the sternum is a very rare accident. Diastasis of the first from the second bone is more often met with, and is a less serious affair. These injuries may result from direct violence, from counterstroke (the force being applied to the back), or from muscular action, as in parturition, or in the act of vomiting. The line of separation is usually transverse, though it may be bevelled as regards the thickness of the bone. Malgaigne, Kramer, and Meyer have each observed longitudinal fractures of the sternum. The most usual seat of injury is at the junction of the manubrium and gladiolus, and in this situation the lesion is, as already observed, commonly a diastasis, or, according to Maisonneuve, Brinton, and Rivington (who have repeatedly observed a true joint in this position), a dislocation. It is a matter of some importance, as regards the prognosis, to be able to say in any individual case whether the lesion be a true fracture or a diastasis, for in the latter case, the posterior ligament being intact, the patient usually escapes visceral complication. In true fracture, the lung or even the heart may be torn, and, even if these dangers be avoided, there is considerable risk of the subsequent formation of abscess in the mediastinal space. The following may be looked upon as evidences of true fracture, viz., the presence of crepitus, the injury being below the junction of the first and second bones, or the fact of the upper fragment projecting in front of the lower. In diastasis the lower rises in front of the upper fragment. *Direct violence* exerted upon the manubrium has never been known to produce true fracture, while when exerted upon the gladiolus it almost never produces diastasis. In cases of injury from *indirect* violence, if the marks of fracture above given be not present, the diagnosis must be made by noting the presence or absence of hæmoptysis, emphysema, etc.

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[1] See interesting papers by Dr. E. H. Bennett, in the Dublin Journal of Medical Science for March, 1876, and October, 1877.

The ensiform cartilage is rarely the seat of fracture or dislocation, though well-marked cases have been observed by Hamilton, Martin, Billard, Mauriceau, Gallez, and Polaillon.

In making the *diagnosis* of fractured sternum, the possibility of a congenital deformity being mistaken for the result of violence, must not be overlooked. The detection of crepitus and mobility may be facilitated, as suggested by Desprès, by placing a cushion beneath the back, so as to render the front wall of the thorax prominent. The diagnosis in cases of fracture from counterstroke may, according to Hewitt, be aided by noting the occurrence of ecchymosis some days after the reception of the injury. The *prognosis* of diastasis, or of uncomplicated fracture, is favorable; union usually takes place in from three to four weeks. The *treatment* consists in keeping the parts at rest, by the application of a broad compress, held in position with adhesive strips or bandages. If there be much displacement, attempts at reduction may be made, by straightening the spine and drawing the shoulders backwarks. Opium will usually be required, and any thoracic complications must be met by suitable remedies. *Mediastinal abscesses* should be opened at the side of the sternum, when pointing occurs; they have been evacuated by Gibson and others by the use of the trephine, but the results of the operation do not warrant its repetition.

Pelvis.—Fractures of the pelvis are chiefly interesting on account of the liability to implication of the adjacent viscera. One of the *Ossa Innominata* may be broken, the injury being sometimes limited to a separation of the crista ilii, or of one of the spinous processes, and at other times passing through the rami of the pubis or ischium, or in the neighborhood of the sacro-iliac symphysis. The ilium, pubis, and ischium may separate in their lines of conjunction, the acetabulum being thus split into three portions; or diastasis may occur at the pubic or sacro-iliac symphyses. Fractures of the pubis and ischium assume a somewhat oblique direction, while those about the sacro-iliac junction correspond pretty generally to the line of the symphysis.

The *diagnosis* of fractured pelvis can usually be made without much difficulty. There is great pain, aggravated by motion, and especially by any attempt to walk or stand; there is abnormal mobility; and crepitus can be elicited by grasping the ilia in either hand and moving them in opposite directions. The displacement in fractures of the pubis and ischium is often considerable, and can usually be readily detected. These injuries are commonly caused by great violence of a crushing nature, such as the fall of a bank of earth. In one case, which was under my care, the crest of the ilium was knocked off by a sharp blow resulting from the fall of a stove-pipe. The pubis has sometimes been fractured as the result of muscular contraction, as in a remarkable case recorded by M. Letenneur, while diastasis of the pubic, and occasionally of the sacro-iliac, symphysis may occur in the process of parturition. *Fracture of the Acetabulum* is an accident that is often spoken of as complicating dislocation of the hip. I believe, however, with Prof. Bigelow, that this fracture is much rarer than is generally supposed, and that its existence should never be assumed unless crepitus can be detected at the seat of supposed lesion, while even in such a case the injury (as pointed out by Birkett) may really consist in a luxation, complicated with fracture of the head of the femur. Fracture of the acetabulum may consist merely in a separation of its posterior lip, or in a destruction of its floor, attended sometimes with impaction of the head of the femur in the pelvic cavity. The latter form of injury is commonly attended with such severe visceral lesions as to prove fatal. Separation of the lip of the acetabulum is marked by the signs of dislocation, the displacement being readily reduced *with crepitus*, but as readily reproduced when extension is discontinued.

The great danger in cases of fracture of the pelvis is from rupture or laceration of the bladder or urethra. Hence the surgeon's first step should be to pass a catheter, with a view of ascertaining the condition of those organs; if they are found to have been injured, prompt treatment must be employed, according to the principles which will be laid down in speaking of Injuries of the Pelvic Viscera.

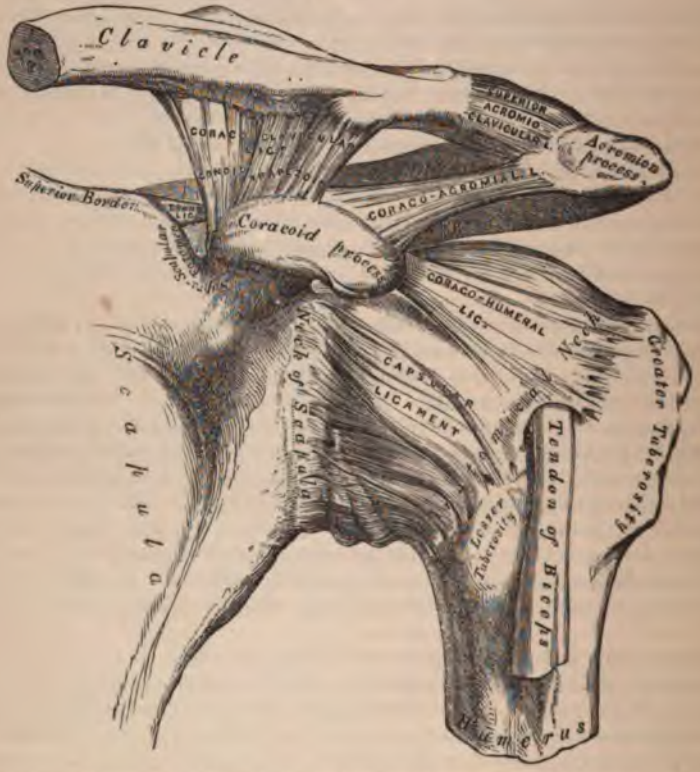
The *treatment* of fractured pelvis consists in the first place in restoring the displaced fragments to their proper position, if this can be done without violence; in the case of a woman, reduction may be assisted by introducing one or more fingers into the vagina. The entire pelvis should be surrounded by a padded belt, or firm and broad roller, so as to keep the parts at perfect rest, while the hip-joint of the affected side is fixed by means of a pasteboard splint or a sand-bag, as in cases of fractured thigh. The patient should lie on his back, on a hard mattress, with the knees slightly flexed, and supported by pillows. *Compound fractures of the pelvis* are usually fatal accidents, though I have seen recovery after perforating gunshot fracture of the ilium. In the treatment of such a case, all splinters should be carefully removed, and means adopted to secure free drainage through the external wound.

Sacrum and Coccyx.—Fractures of these parts usually result from direct violence, the fracture being transverse, and the lower fragment pressed inwards upon the rectum. Richerand gives one case of longitudinal fracture of the sacrum. These injuries are rarely met with except in connection with other severe pelvic lesions, and are then apt to prove fatal; the treatment would consist in endeavoring to effect reduction by pressure from within the rectum, and in the application of a padded belt. Bernard, a French surgeon, plugged the rectum with a lithotomy tube, in order to maintain reduction, but I should prefer, with Hamilton, to dispense with such an instrument and rely upon keeping the parts at rest and administering opium. Fracture of the coccyx sometimes results in the development of a very painful neuralgic condition of the part, constituting a form of the affection described by Dr. Nott and Sir J. Y. Simpson, and known as *coccygodynia;* the treatment recommended by those gentlemen consists in subcutaneous division of the ligamentous attachments of the part, or, if that fail, in excision of the bone itself, an operation which has been successfully resorted to by several surgeons, including Dr. Burnham, Dr. Mursick, Dr. Morton, and myself.

FRACTURES OF THE UPPER EXTREMITY.

Clavicle.—The clavicle is peculiarly liable to fracture, not only from its exposed position, but from the fact of its being the sole bond of osseous connection between the trunk and the upper extremity. It may be broken by *direct* violence in any part of its length, but is much oftener fractured by *indirect* violence (such as a fall or blow on the shoulder), and then usually gives way near the outer end of its middle third, where the bone is weakest. *Partial* fracture from *indirect* violence is usually situated towards the inner end of the middle third, and is characterized by slight angular *projection.* *Partial* fracture from *direct* violence is commonly situated more externally, and is marked by angular *depression.* *Muscular action* is an occasional cause of fractured clavicle, particularly, according to Delens, of fractures of

FIG. 113.

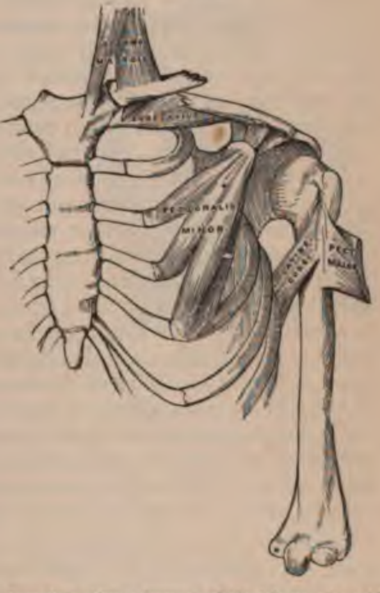


Attachments of outer end of clavicle; showing branches of coraco-clavicular ligament. (GRAY.)

the inner third of the bone; the immediate mechanism of the accident in some cases may be, as suggested by Dr. Packard, the bending of the clavicle over the first rib, which acts as a fulcrum. Fractures from direct violence are commonly transverse, and may occasionally be comminuted; fractures from indirect violence are almost invariably oblique, the bevelling being from before backwards, and from without inwards. Fracture of the sternal end of the clavicle, *within the fibres of the costo-clavicular ligament*, is usually attended with but little displacement, though, according to R. W. Smith, the outer fragment is in these cases displaced *forwards*, or *forwards and slightly downwards;* similarly, there is little displacement in fracture of the outer third, *within the limits of the coraco-clavicular ligament*, but if the fracture be *outside of the trapezoid branch* of that ligament, the displacement, according to the same surgeon, is quite marked. According to A. Gordon, however, even the existence of the last-named variety of fracture is doubtful. Fractures of the middle of the clavicle, especially such as are produced by indirect violence, are accompanied with great and very constant displacement. This consists in a tilting upwards of the inner fragment, and a dropping of the outer fragment, which is also rocked inwards and somewhat backwards by the action of the powerful muscles attached to the scapula, particularly the rhomboidei, trapezius, levator anguli scapulæ, pectoralis minor, and some fibres of the serratus magnus.

The *diagnosis* of fractured clavicle can usually be made without difficulty: if the middle of the bone be involved, the displacement is in itself sufficiently characteristic, while crepitus can readily be elicited in any position of the fracture, on account of the subcutaneous character of the bone in its whole length. In cases of partial or partially impacted fracture from direct violence, an accident of not unfrequent occurrence among quite young children, persistent tenderness over the point of injury will be found a valuable diagnostic sign. The attitude of the patient, in cases of complete fracture, is peculiar, and often significant of the nature of the injury; the head is bent towards the affected side, so as to relax the muscles, while the elbow and forearm are supported in the opposite hand, so as to diminish the dragging sensation produced by the weight of the limb. The *prognosis*, as regards the life of the patient and the utility of the limb, is very favorable; I believe, however, that a *perfect cure*—that is, without deformity—is very rarely obtained, at least in oblique fractures of the middle of the bone. *Comminuted fracture* of the clavicle is sometimes a serious injury, from concomitant laceration of the subclavian vein or plexus of nerves. *Compound fracture* of this bone is rare, except as the result of gunshot injury, when it is apt to prove fatal from thoracic complications; I had, however, under my care, some years ago, a case of multiple fracture of

FIG. 114.



Complete oblique fracture of clavicle near its middle. (GRAY.)

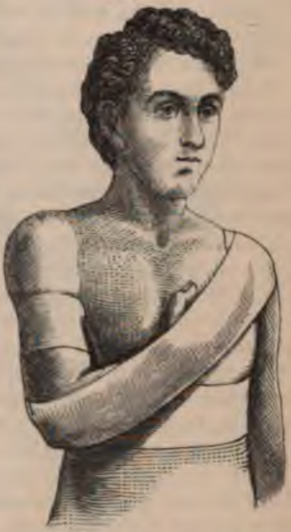
the clavicle from direct violence, which became secondarily compound by the occurrence of suppuration; slight necrosis followed, but the patient eventually made a good recovery. Fracture of *both clavicles* is an accident of rare occurrence, but presents no peculiarities, except that of course it requires some modification of the apparatus used in treatment.

Treatment of Fractured Clavicle.—The treatment of fractured clavicle may be conducted by position alone, or by position aided by various forms of apparatus. The deformity, as we have seen, depends (1) on the tilting up of the inner fragment, by the resiliency of its ligamentous attachments and the action of the sterno-cleido-mastoid muscle; (2) on the falling of the shoulder with the outer fragment, due to the weight of the arm; but (3) chiefly on the rocking inwards and backwards of the outer fragment, by the action of the powerful muscles attached to the scapula. Hence the indications for treatment are, (1) to relax the sterno-cleido-mastoid muscle, (2) to prevent the weight of the arm from dragging down the outer fragment, and (3) by fixing the scapula, to carry the attached external fragment outwards and forwards, and thus restore the shape of what has been not inaptly called the "*shoulder girdle.*" These indications may all be met by position alone. For this purpose the patient should lie flat on his back, on a firm, hard mattress, with the head slightly elevated, and the arm flexed and carried across the chest, so that the hand rests on the sound shoulder—the position commonly known as the "Velpeau position," from its having been employed by that distinguished surgeon in the treatment of these and other injuries (see Fig. 116). The elevation of the head (by means of a single pillow, which must not touch the shoulders) relaxes the sterno-cleido-mastoid muscle, and thus obviates the tendency to upward tilting of the inner fragment; the position of the arm across the chest makes the weight of the limb act, if at all, in an upward direction, and thus effectually prevents any downward displacement; while the weight of the chest, together with the firm and even counter-pressure of the mattress, serve to fix the scapula, and thus prevent that rocking of the bone around the chest which causes the inward and backward displacement of the outer fragment. By this simple mode of treatment the deformity can, at least in the immense majority of cases, be completely reduced, and could the patient be trusted to remain quiet for a sufficient length of time (three to four weeks), nothing further would be required. In practice, however, very few patients can help shifting their posture in sleep, if not while awake, and hence *retentive apparatus* is usually necessary. If the patient can remain in bed, the scapula may be fixed by a broad and long wedge-shaped pad, applied as a compress on the lower blade of the bone, and held in place by several broad strips of adhesive plaster, while the arm is fastened in the "Velpeau position" by a few strips of the same material. If the patient cannot remain in bed, the same appliances may be used, with the addition of a compress upon the projecting end of the inner fragment, and a broad roller bandage used as what is known as the "third roller of Desault,"[1] with additional circular turns to fix the arm in the required position. The same indications may be met by using Fox's apparatus (to be presently described), or any of

[1] The application of the third roller of Desault is thus described by Wales: Place the initial extremity of the roller "under the axilla of the sound side, then conduct the cylinder over the broken clavicle, upon which a compress must be placed, down the posterior surface of the arm under the elbow, and over the forearm to the point of departure; thence across the back obliquely over the injured shoulder, down the front of the arm and under the elbow, to pass obliquely across the chest to the axilla of the sound side." These turns are repeated until the roller is exhausted, thus forming two triangles, one in front and the other behind the chest; the firmness of the bandage may be much increased by making additional circular turns as recommended in the text.

its modifications, taking care to apply the pad—*not* as an axillary fulcrum, but simply as a scapular compress. The posterior figure of 8 bandage, recommended by some authors, is defective in that its force is exerted on the acromial part of the scapula only, and not on the entire bone; the same objection applies to most of the back splints devised for these cases, though a back splint, such as that devised by Dr. Staples, of Minnesota, broad enough to fix both scapulæ, might be made a useful adjuvant to the compresses already described. Vacher, of Birkenhead, has modified the figure of 8 bandage by applying metallic caps to both shoulders, and drawing them backwards by means of a posterior strap and buckle. The apparatus introduced by Dr. George Fox, of this city, is thus described by Sargent: "The apparatus consists of a firmly stuffed pad of a wedge shape, and about half as long as the humerus, having a band attached to each extremity of its upper or thickest margin; a sling to suspend the elbow and forearm, made of strong muslin, with a cord attached to the humeral extremity, and another to each end of the carpal portion; and a ring made of muslin stuffed with cotton to encircle the sound shoulder, and serve as means of acting upon and securing the sling." Fox's apparatus has undoubtedly produced a great many excellent cures; it has done so, however, I believe, by *fixing the scapula* more or less perfectly, and not by affording leverage to the humerus, as it was originally intended to do. Indeed, the wedge-shaped pad, if used as a fulcrum, produces so much pain that few patients can endure it for any length of time; so that in practice surgeons generally apply it far back—where it acts merely as a scapular compress—or else reduce its thickness to such a degree that its action as a fulcrum is entirely defeated. Fox's apparatus has been ingeniously modified by Dr. Levis, Prof. Hamilton, and others, and any of these forms of the sling and pad dressing may be used with good results, provided that they are accurately adjusted and carefully watched by the surgeon.[1] Moore, of Rochester, and Sayre, of New York, believe that the point of most importance is to render tense the clavicular fibres of the pectoralis major muscle, and thus draw the inner fragment downwards; the former surgeon accomplishes this purpose by forcing the entire arm backwards, and fixing it with a shawl or strip of muslin folded as a cravat and made to describe figures of 8 around the sound shoulder and the elbow of the affected side; while Prof. Sayre employs two broad adhesive strips, one of which fixes the arm and acts as a fulcrum, while the other forces the shoulder backwards by drawing the elbow forwards, at the same time supporting the forearm, as shown in Fig. 115. Dr. Satterthwaite has modified Sayre's dressing by adding an axillary pad, and employing elastic bands instead of adhesive plaster. Union of a fractured clavicle usually occurs within three weeks, but the dressing should be retained, as a matter of safety, at least a couple of weeks longer.

FIG. 115.



Sayre's dressing for fractured clavicle. (HAMILTON.)

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[1] See a full and able discussion of the principles of treatment of fractured clavicle, and the comparative merits of different forms of apparatus, by Dr. Edward Hartshorne, of this city, in the 2d volume of the *Pennsylvania Hospital Reports*, pp. 108–142.

Scapula.—The scapula may be broken through its body, through its neck, through the glenoid cavity, or through the acromion or coracoid processes.

Fracture of the Body of the Scapula is a rare accident, and is usually due to direct violence, though it is said in one case (Heylen's) to have been produced by muscular action. If the spine of the scapula be involved, the line of fracture can commonly be detected with facility by palpation, and in other cases crepitus can generally be elicited by pressing firmly on the scapula with one hand, while the other moves the shoulder in various directions. The *treatment* consists in attempting to reduce the deformity, if there be any, by manipulation, and in then fixing the arm to the side by circular turns of a roller bandage or by adhesive strips, the forearm and elbow being supported in a suitable sling. If the lower angle have been separated from the rest of the bone, it may be secured, as advised by Boyer, by the additional application of a firm compress.

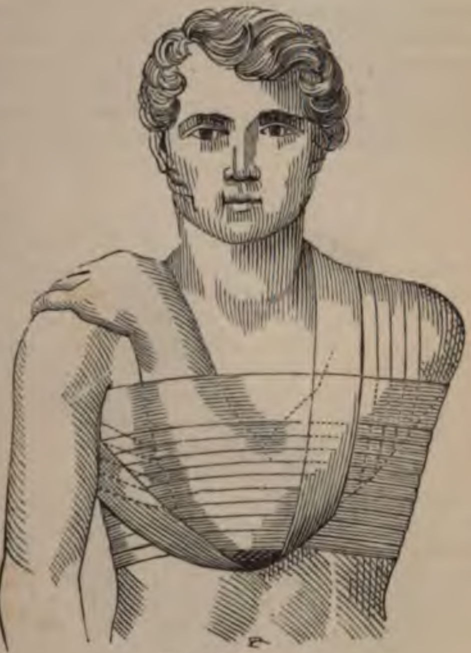
Fracture of the Neck of the Scapula (in the anatomist's sense of the term) is an accident the possibility of which has never been established by dissection, and which, if it have ever occurred, except when complicated with *comminution of the glenoid cavity,* must certainly be very rare. The term "*fracture of the neck of the scapula,*" as used by Sir Astley Cooper, however, means fracture *through the supra-scapular notch,* and in this position the lesion has unquestionably been met with, though very rarely. I have myself seen one example, in a child five years old. The amount of displacement depends on the degree of integrity of the various ligaments of the part, especially the coraco-clavicular and coraco-acromial. If these be ruptured the glenoid cavity and head of the humerus fall into the axilla (where the latter may be sometimes felt), causing a depression beneath the acromion as in dislocations of the shoulder, though not so deep; crepitus is elicited by laying one hand on the shoulder, so as to touch the coracoid process, and with the other hand moving the arm in various directions. In a child the part may be grasped by placing the fingers on the shoulder and thrusting the thumb deeply into the axilla. The deformity can readily be reduced, but instantly recurs when support is removed, and the coracoid process can be felt moving with the humerus, instead of with the acromion. The *treatment* consists in fixing the scapula by placing a thin pad or folded towel in the axilla, fastening the arm to the side by circular turns of a roller or adhesive strips, and supporting the forearm and elbow in a sling. The same dressing would be applicable in a case of *comminution of the glenoid cavity.*

Fracture of the Acromion is probably a rarer accident than epiphyseal separation of that process. When the line of fracture is through or behind the acromio-clavicular articulation, the shoulder drops forwards, inwards, and downwards, as in cases of fractured clavicle; if, however, the fracture be in front of the acromio-clavicular articulation, there will be little or no displacement, and the diagnosis must be made by the detection of mobility and crepitus. Union occurs without much deformity, though rarely, according to Cooper, except by fibrous tissue. The *treatment* consists in fixing the arm and scapula by an axillary pad and bandage, and in supporting the elbow with a sling. This, as well as fracture of the body or neck of the scapula, may be also efficiently treated with the bandage known as Velpeau's, the application of which can be seen from the accompanying illustration.

Fracture of the Coracoid Process occasionally, though rarely, occurs, as the result of direct violence. There is seldom any displacement, and no *treatment* is required beyond the use of a sling, with perhaps a few turns of a roller around the arm and shoulder.

Two or more of these various forms of scapular fracture may coexist in the same case, or any one of them may be complicated by fracture or dislocation of the humerus or clavicle; for the treatment of such injuries no general rules can be laid down, but each case must be managed with reference to its own peculiar exigencies. The ingenuity of the surgeon will often be much taxed in endeavoring to meet the different indications presented, and he will often be disappointed by the persistence of deformity, which, however, fortunately seldom proves much of an impediment to the usefulness of the arm. The time required for treatment, in cases of fractured scapula, is usually from three to four weeks.

FIG. 116.



Velpeau's bandage.

Fractures of the Humerus.—Fractures of the humerus are divided by Hamilton into eleven classes, of which four are fractures of the upper extremity (head, neck, and tubercles), one of the shaft, and six of the lower extremity.

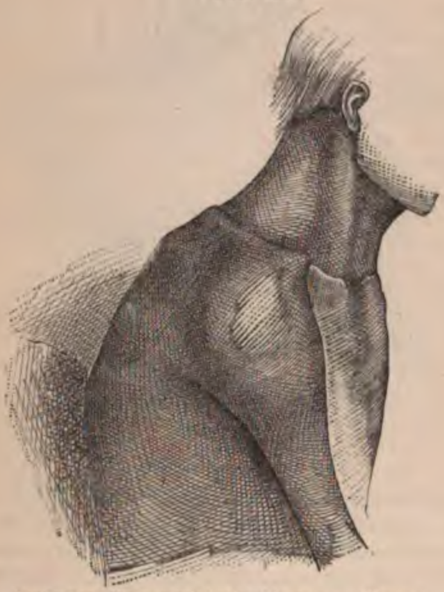
1. Fractures of the Upper Extremity of the Humerus.—(1.) The fracture may pass through the *Head and Anatomical Neck* of the bone, being chiefly intra-capsular, and may or may not be impacted, according to circumstances. If the fracture be *entirely intra-capsular*, bony union cannot well occur, and the detached head of the humerus is apt to become carious or necrosed, requiring an operation for its removal. Fracture of the anatomical neck is attended with but little deformity, nor does it much interfere with the motions of the part. There may be slight shortening, and crepitus can usually be elicited by pressing the head of the bone into its socket and making rotation; the shoulder is the seat of severe pain. This injury results from direct violence, and is principally met with in old persons.

(2.) *Fracture through the Tubercles* of the humerus differs from the preceding variety merely in being completely *extra-capsular*. Bony union takes place in these cases, but the motion of the joint is apt to be impaired by the irregular masses of callus which are formed. Crepitus may be detected by grasping the tubercles with one hand, and rotating the arm with the other; there is rarely much displacement, though, if the fracture be impacted, there may be slight shortening. The signs of this injury are very obscure, and in many cases the diagnosis cannot be positively made during life.

(3.) *Longitudinal Fracture of the Head and Neck, or Splitting off of the Greater Tubercle*, produces a marked increase in the antero-posterior diameter of the upper end of the humerus, and, while there is some depression under the acromion, a smooth, bony prominence can be felt under the coracoid process; crepitus can be usually elicited by pressing together the tubercles and rotating the arm, while the mobility of the limb is unimpared. Union takes place by bone, or by fibrous tissue, according to the amount of separation between the fragments.

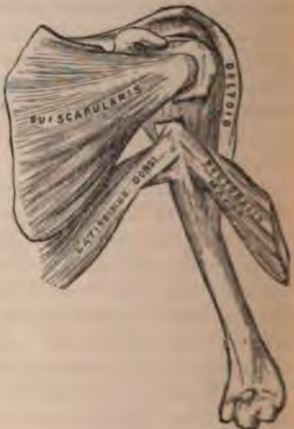
(4.) *Fracture of the Surgical Neck* of the humerus, under which head may be included separation of the upper epiphysis, is the most frequent form of injury met with in this region. The *surgical neck* is that part of the humerus which extends from the line of epiphyseal junction to the place of insertion of the latissimus dorsi and pectoralis major muscles. Fracture of this part usually results from direct violence, and is often accompanied with great contusion and swelling of the soft parts. Separation of the epiphysis (Fig. 117) is an accident of early life, but true fracture, though met with in children, is more frequent among adults. Crepitus can be readily elicited, unless either impaction or overlapping have occurred; in the latter case the diagnosis can be easily made from the deformity, which is characteristic, and which consists in the upper end of the lower fragment being drawn upwards, inwards, and forwards, while the upper fragment is rotated outwards. Reduction is often difficult and sometimes impossible in these cases, in spite of which, union commonly occurs without material impairment of the usefulness of the limb.

FIG. 117.



Separation of upper epiphysis of humerus. (From a patient in the Episcopal Hospital.)

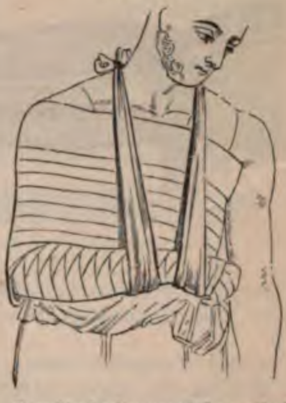
FIG. 118.



Fracture of the surgical neck of the humerus. (GRAY.)

Treatment of Fractures of the Upper Extremity of the Humerus.—*Compound fractures* of these parts, especially if resulting from *gunshot injury*, usually require either excision or amputation. The treatment of *simple* fractures of the upper end of the humerus may be conducted satisfactorily in the following way. A roller should be in the first place applied smoothly and evenly to the injured arm, from the tips of the fingers to, *but not above*, the seat of fracture. This bandage should be applied while the elbow is in a flexed position. A thin pad, compress, or folded towel is then to be placed in the axilla, so as to fill up the hollow of that part and afford a firm basis of support to the humerus. This pad may be held in place by a bandage or by adhesive strips. The arm is then brought to the side, with the elbow a little forwards, so as to obviate the anterior angular projection, and sufficient extension made to reduce the fracture. The arm is to be securely fastened to the chest with circular turns of a roller or adhesive strips, and the forearm secured across the chest, somewhat as in the "Velpeau position," or merely supported by a sling, as may be found most convenient. After a few days, when swelling has subsided, a moulded pasteboard or gutta-percha cap may be applied to the shoulder and upper half of the humerus, and will give additional security and firmness to the dressing. This simple mode of treatment, which is very similar to that recommended by Fergusson (Fig. 119), will, I think, be found quite as efficient and a great deal less annoying to the patient than the angular splint, short splints, and axillary pad often used for the purpose. Erichsen uses a pad, a leather shoulder-cap, and a sling, while Hamilton employs a simple outside splint of gutta-percha without any pad. Welch's shoulder-splint may be also used in the treatment of those injuries.

FIG. 119.

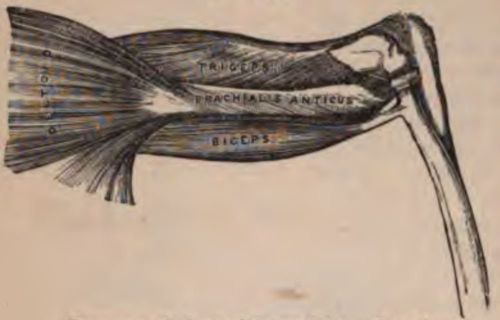


Dressing for fracture of the surgical neck of the humerus. (FERGUSSON.)

2. Fracture of the Shaft of the Humerus is an accident of frequent occurrence, and may result from either direct or indirect violence. The *seat of the fracture* is more often below than above the middle of the bone, and its line usually somewhat oblique, from above downwards and outwards. The *displacement* consists in the drawing upwards and inwards of the lower fragment, with some eversion of the upper fragment, and an anterior angular projection, due to the weight of the forearm. The *diagnosis* is easy, the increased mobility and crepitus rendering the nature of the injury almost unmistakable. The *treatment* consists in the application of a bandage up to, but not above, the seat of fracture (until after the subsidence of swelling), and the use of an internal angular splint, with an outside splint moulded from pasteboard or gutta-percha. If the anterior angular deformity give any trouble, the internal may be replaced by an anterior angular splint, or a short anterior splint may be used with the moulded pasteboard splint, while the forearm is laid across the chest, and fixed by a broad bandage, or merely supported by a short sling around the wrist. Various plans of making permanent extension have been proposed, but are all of questionable utility, sufficient extension being afforded by the weight of the elbow, which for this purpose should be unsupported, or, at least, not pressed upwards. If the internal angular splint be used, care should be taken that it do not press on the axillary vein; the angle of the splint may be varied at different dressings so as to avoid stiffness of the elbow.

3. Fractures of the Lower Extremity of the Humerus.—(1.) Of these, the first to be considered is the *Fracture at the Base of the Condyles* not implicating the joint, under which head may be properly included separation of the lower epiphysis of the humerus. This form of fracture usually results from indirect violence exerted upon the extremity of the elbow, and its line is generally oblique, upwards and backwards. This injury is frequently confused with dislocation of the elbow backwards, but the *diagnosis* can be made by observing that in *fracture* there is increased mobility, crepitus, shortening of the humerus, but no change in the relative position of the olecranon and condyles, and that the deformity, while easily reduced, instantly recurs on the removal of extension. In *dislocation*, on the other hand, there is immobility, no crepitus, no shortening, but an obvious projection of the olecranon behind the line of the condyles, and the displacement when reduced does not return.

FIG. 120.

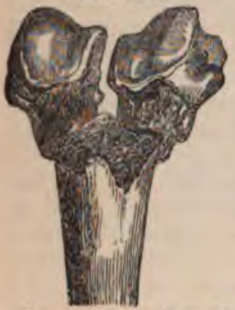


Fracture at the base of the condyles. (GRAY.)

(2.) *Fracture at the Base of the Condyles, complicated by a Splitting Fracture between them*, is a somewhat rare accident; it is marked by the same symptoms as the preceding variety, with the addition of *increased breadth of the lower end of the humerus*, and of *crepitus between the condyles*, developed by pressing them together.

Besides the above varieties, there may be separate fractures of (3) the *Inner Condyle* (trochlea), (4) the *Inner Epicondyle* (epitrochlea), (5) the *Outer Condyle*, and, possibly, (6) the *Outer Epicondyle*, though I am not aware that the existence of this lesion has ever been demonstrated by dissection. The diagnosis of these varieties of fracture can usually be made by the detection of mobility and crepitus, elicited by grasping the arm firmly with one hand, and moving either condyle successively in various directions, or by pressing and rubbing the condyles together. There is commonly not much displacement, except in case of fracture of the inner epicondyle, when the separated fragment is often displaced downwards in the direction of the hand. These injuries generally result from direct violence, and after recovery the elbow is often left stiff, if not absolutely anchylosed.

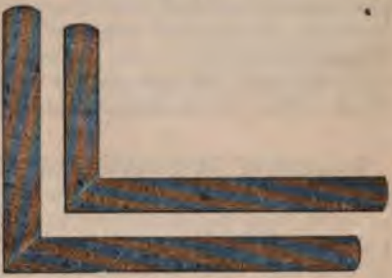
FIG. 121.



Fracture at the base of, and between the condyles. (ERICHSEN.)

Treatment of Fractures of the Lower Extremity of the Humerus.—Any of these fractures may be conveniently and efficiently treated by means of a simple internal rectangular splint (Fig. 122), the forearm being in a semi-prone position with the thumb pointing upwards, or by means of an anterior angular splint, the forearm being supine. The splints should be well padded, and no bandage should be applied *beneath* the splint, until after the subsidence of inflammatory swelling. Indeed, the soft parts are often so much involved in these cases, that the use of evaporating lotions may be required for a few days, the limb being bandaged to the splint above and below, while the joint itself is left exposed. Several forms of apparatus have been devised for the treatment of these injuries, among the most ingenious of which may be specially mentioned the splints of Sir A. Cooper, Hamilton, Bond, Welch, and Mayo. I am not aware, however, that they present any advantages over the simple form of dressing above recommended; whatever plan be adopted, great care must be taken to avoid undue or uneven pressure, which might produce excoriation or even gangrene. Great difficulty is sometimes experienced in maintaining reduction, from the action of the powerful muscles at the back of the arm; by careful bandaging, however, and the judicious use of compresses, this difficulty can usually be overcome.[1] As already mentioned, if the elbow-joint be involved in the fracture, there will always be great risk of anchylosis; hence, it may be proper to resort to passive motion at a comparatively early period in these cases, as soon sometimes as the end of the third or fourth week; or the patient may be directed to swing a flat-iron, as recommended in the last chapter. *Compound fracture of the elbow-joint* is a very serious injury, and usually requires excision or amputation.

FIG. 122.



Physick's elbow splints.

The time required for the treatment of a fractured humerus is commonly from five to eight weeks, according to the age of the patient, and other modifying circumstances.

Fracture of the Olecranon is usually produced by direct violence, such as a fall on the point of the elbow. It may also be caused by indirect violence—a fall on the hand, etc.; or even by muscular action, through the powerful contraction of the triceps extensor muscle. In the latter case, the mechanism of the injury probably consists in the olecranon process being broken as an overbent lever, across the condyles of the humerus, which act as a fulcrum. The symptoms of the accident are sufficiently obvious. If the ligamentous expansion of the triceps be extensively ruptured, the detached process will be drawn a considerable distance up the arm, giving rise to marked displacement. In the majority of instances, however (at least according to my own experience), there is little or no separation, and the diagnosis must then be made by noting the existence of abnormal mobility and of crepitus. Crepitus can commonly be elicited simply by seizing the olecranon and rubbing it laterally against the extremity of the shaft of the ulna, or, if there be any displacement, by grasping the forearm just below the elbow, so that the forefinger rests upon the point of the olecranon, which it draws down in contact with the shaft, when crepitus may be brought out by flexing and extending the forearm with the other hand. Union occasionally takes place by bony deposit, but is more often ligamentous merely. The utility of the arm may, however, be preserved even with considerable retraction of the upper fragment. The *treatment* consists in fixing the olecranon in apposition with the shaft (which may be conveniently effected by means of a compress and adhesive strips), and keeping the joint at rest in an extended position for four or five weeks, or until union has occurred. Surgeons are divided as to the comparative advantages of *complete* or of *partial* extension, many agreeing with Sir Astley Cooper and Prof. Hamilton, in recommending the former, while the majority of French surgeons, Mr. Erichsen, and others, prefer the latter. I am myself in the habit of using a simple obtuse-angled splint, well padded, and applied to the inside of the arm and to the palmar surface of the forearm, which is kept in a semi-prone position. Figure of 8 turns around the elbow assist in fixing the olecranon. This position—one of slight flexion—is less irksome to the patient, and is at least as effective in obviating deformity as that of complete extension, which sometimes causes an angular depression at the seat of fracture. In cases of *compound fracture of the olecranon,* or of any compound fracture about the elbow-joint, in which an attempt is made to preserve the limb, the arm should be flexed to an angle of from 100° to 120°, which will be found the most useful position should anchylosis ensue.

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[1] Dr. T. Blanch Smith reports a case in which, others means failing, reduction was maintained by extending the forearm upon the arm, and applying a long *straight* splint. Dr. Allis, of this city, also employs the extended position in the treatment of these injuries.

Fracture of the Coronoid Process of the Ulna has been supposed to be a frequent complication of backward dislocation of the elbow-joint. I have, however, been unable to refer to more than twenty cases in which this lesion has been diagnosticated during life (and in none of them does the diagnosis seem to have been confirmed by dissection), while only three of nine specimens described by authors appear to give satisfactory evidence as to the existence of fracture. Hence, though the possibility of the accident must be admitted, it must be considered very rare. The *cause* of such an injury would probably be indirect violence, and its *diagnosis* would have to be established principally by exclusion. The *treatment* would consist in fixing the elbow on a rectangular splint, and in practising passive motion after three or four weeks.

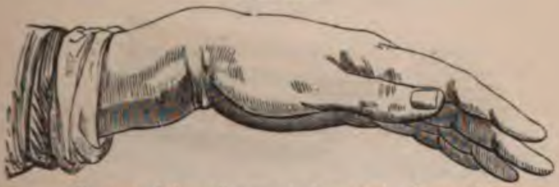
Fractures of the Forearm.—Both bones of the forearm are frequently broken through their shafts, either by direct, or more frequently by indirect, violence, while by direct violence either the radius or the ulna may be fractured separately. If only one bone be broken, the other acts as a splint, and prevents the occurrence of much displacement, in spite of the obliquity of the fracture; but if both bones have given way, there is marked shortening, which, with the mobility and crepitus, render the nature of the case evident. The *treatment* consists in reducing the deformity by extension and manipulation, and in fixing the limb so that the line of the bones is preserved, and the interosseous space not encroached upon, while the motions of pronation and supination are preserved. For this purpose the *supine* position, advised by Lonsdale, is preferable to that of semi-pronation ordinarily recommended. The reason is that in any fracture of the radius, particularly in one above the insertion of the pronator radii teres, the *upper* fragment is supinated by the action of the supinator brevis and biceps muscles, and therefore, unless the *lower* fragment be also supinated by the surgeon, union with rotatory deformity will almost inevitably ensue. Two straight splints are required, which should be just wide enough to prevent the encircling bandage from pressing the bones together, and thus diminishing the interosseous space. The palmar splint should reach from the bend of the elbow to beyond the fingers; the dorsal from just below the olecranon to just above the styloid process of the ulna. They should be well and evenly padded, the object being *not* to thrust the bones apart as by a wedge, but to fix them in the position which they have assumed under the surgeon's manipulations. *No bandage should be used underneath the splints,* and the dressing should be renewed at least every other day during the first fortnight. For fracture of both bones, the splints should be retained for from five to seven weeks, but for fracture of the shaft of either bone alone, four weeks will usually suffice. A *perfect cure* of a fracture of both bones of the forearm is perhaps rarely obtained; but I believe that the surgeon will secure better results by this mode of treatment than by any other.

Fracture of the Head of the Radius is a rare form of injury which does not appear to have been recognized during life, though the possibility of its occurrence has been demonstrated by dissection.

Fracture of the Neck of the Radius is rarely met with except when complicated with other lesions. The diagnostic signs are slight anterior displacement, with localized pain, mobility, and crepitus. The *treatment* consists in the application of a well-padded internal rectangular splint, the separated fragment being kept in place by means of a firm compress.

Fracture of the Lower Extremity of the Radius is an accident of very frequent occurrence. Its nature and pathology have been made the subject of special study by Colles, R. W. Smith, Erichsen, Goyrand, Voillemier, Nélaton, Barton, Gordon, Moore, and Pilcher, of New York. There are two varieties of this form of fracture, which are known generally in this country as Colles's and Barton's fractures. *Colles's fracture*, which is by far the most common, is a transverse or slightly oblique fracture, situated at from a quarter of an inch to an inch and a half above the articular extremity of the radius. *Barton's fracture* is a very oblique fracture, extending from the articulation upwards and backwards, separating and displacing the whole or a portion of the posterior margin of the articulating surface. It is a very rare accident, constituting probably not more than one or two per cent. of the whole number of fractures in this locality. The cause of these injuries is almost invariably a fall upon the palm of the hand, the position of over-extension causing the bone to give way, as pointed out by Gordon, by what mechanicians call a "cross-breaking strain;" the displacement is very constant, the lower fragment being drawn somewhat upwards and backwards, while the upper fragment projects downwards and forwards; the hand at the same time inclines somewhat to the radial side, though if, as sometimes happens, there be also a fracture of the styloid process of the ulna, this symptom may not be present. In some cases, according to Moore, of Rochester, the styloid process is dislocated and caught beneath the annular ligament, from which position it must be released before reduction can be accomplished. The so-called "silver fork" deformity, which usually characterizes this injury, is well seen in the accompanying illustration (Fig. 123). The *diagnosis* of this fracture is generally easy. Beside the peculiar displacement, there is pain, greatly increased by motion and especially by attempts to rotate the wrist, while crepitus can be readily elicited by drawing down the hand and rubbing together the fragments. In some rare cases the fracture is completely impacted, when crepitus will be absent, and reduction very difficult, if not impossible. The *treatment* consists in effecting reduction by means of extension and manipulation, and in fixing the limb by the use of splints and compresses. Two compresses are required, one over the dorsal projection (lower fragment), and one over the palmar prominence (upper fragment). Two straight splints

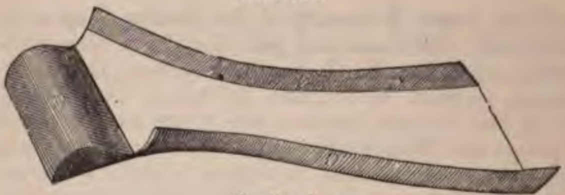
FIG. 123.



Fracture of the radius near its lower end. (LISTON.)

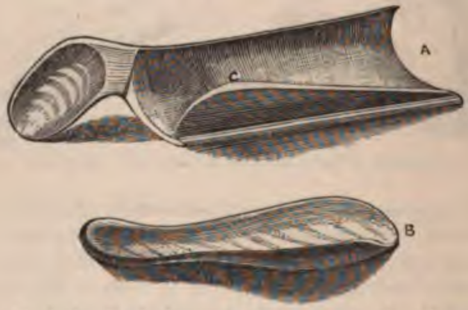
may be applied over these compresses (as recommended by Dr. Barton), or, which I prefer, the well-known splint of Dr. Bond (Fig. 124) may be used, or one of the ingenious modifications of Drs. Hays, Hamilton, and others. To any of these a short dorsal splint may be sometimes advantageously added. Bond's splint consists of a piece of wood, of the shape indicated in the figure, with a carved block to support the hand and fingers, and side strips of leather or pasteboard. It is prepared for use by placing in it a layer of cotton wadding or folded lint, and adjusting upon this the palmar compress in such a position that, when the splint is applied, it will press accurately upon the lower end of the upper fragment. The splint is laid on the fractured limb, so that the hand folds lightly over the block (which should fit the hollow of the palm), and the dorsal compress is then adjusted to the lower fragment so as to maintain the reduction which has hitherto been kept up by the surgeon's hands. The dressing is completed by the application of a roller bandage, *firmly*, but not *tightly*, for fear of gangrene. Another efficient, but, as it seems to me, unnecessarily complicated apparatus, is that employed by Dr. A. Gordon, of Belfast, which, like the splint devised by Dr. Carr, of New Hampshire, employs a curved instead of a plane surface for the support of the broken bone. The *semi-prone* position is that usually recommended for the treatment of this injury, but I myself prefer the position of *supination*, which I have already advised for fractures of both bones of the forearm. When Colles's fracture is complicated with *Fracture of the Styloid Process of the Ulna*, the case should be treated with two straight splints, as an ordinary fracture of the forearm, with the addition of compresses to combat the "silver-fork" deformity, if required. Five to seven weeks are usually necessary for the treatment of these cases.

Fig. 124.



Bond's splint.

Fig. 125.



Gordon's splint for fracture of the lower end of the radius.

Fractures of the Hand.—Fracture of the *carpus* or *metacarpus* should be treated on a broad palmar splint, which is so padded as to fill up the hollow of the hand, and afford firm support to the injured member; fractures of the *phalanges* commonly require, in addition, a small pasteboard splint, applied immediately to the injured finger. The use of apparatus may be dispensed with after two or three weeks.

In the treatment of all fractures of the upper extremity, the limb should (unless fastened to the chest) be supported in a sling, which may, within reasonable limits, be lengthened or shortened according to the patient's preference or fancy.

FRACTURES OF THE LOWER EXTREMITY.

Femur.—Fractures of the thigh-bone may be divided into—1, those of its upper extremity; 2, those of its shaft; and 3, those of its condyles.

1. Fractures of the Upper Extremity of the Femur are usually classified as fractures (1) of the neck within the capsule, (2) of the neck without the capsule, (3) of the neck, partly intra- and partly extra-capsular, (4) through the trochanter major and base of the neck, and (5) of the epiphysis of the trochanter major. The terms intra- and extra-capsular have, however, as justly remarked by Prof. Bigelow, not much practical significance, for the reason that the attachment of the capsule varies in different individuals, so that, apart from the difficulty of diagnosis during life, it is often impossible, in looking at a specimen which shows bony union, to say whether the fracture was originally inside or outside of the capsular ligament. Hence, this distinguished surgeon divides these injuries merely into the *impacted* and *non-impacted* varieties of fracture. The old classification, however, is at least unobjectionable, and may properly be retained, as being more familiar than any other.

1. *Intra-capsular Fracture of the Neck of the Thigh-bone* is an accident of frequent occurrence, being met with principally in those of advanced life, and in women oftener than in men. It is predisposed to, by the ordinary senile change in the structure and shape of the cervix femoris, which is, in old age, often less obliquely attached to the shaft than in earlier life. This form of fracture results, usually, from indirect violence of an apparently trivial nature, such as slipping from a curbstone, tripping over a loose piece of carpet, or even turning in bed. The *symptoms* are alteration in the shape of the hip, pain, crepitus, inability to stand or walk, shortening, and eversion of the foot.

Alteration in the shape of the hip is evidenced by *flattening of the trochanter*, which may also be observed to *rotate in an arc of abnormally small radius*, the reason being that its centre of motion is changed from the acetabulum to the seat of fracture. Dr. Allis has observed that, in the erect posture, the fascia lata is relaxed upon the injured side; and flaccidity of the tensor vaginæ femoris and glutæus medius muscles is regarded by Bezzi and Lagorio as a sign of pathognomonic value.

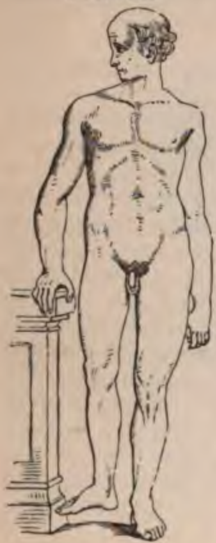
Pain is markedly increased by any motion of, or pressure on, the joint, and is sometimes so intense as to render the use of anæsthesia necessary as an aid to diagnosis.

Crepitus may sometimes be detected by simply rotating the limb, but is usually not elicited until, by means of extension, the separated fragments are brought into contact.

Inability to stand or walk is usually present from the first, though instances are not wanting in which patients have walked a short distance after the accident before falling, probably from the fracture being at first incomplete, or partially impacted. The *attitude of the limb*, as shown in the accompanying illustration (Fig. 126), is often characteristic, and sometimes almost diagnostic.

The *shortening*, in these cases (as ascertained by measuring both limbs from the anterior iliac spines to the tips of the inner malleoli), is commonly not very marked at first—probably not exceeding half an inch to an inch; it subsequently, and often suddenly, increases, by the giving way of ligamentous attachments, by rupture or stretching of the capsule, or by unlocking of fragments, and not unfrequently amounts, under these circumstances, to two inches or even more.[1]

FIG. 126.



Fracture of the neck of the femur. (FERGUSSON.)

Eversion of the limb almost always accompanies these cases, and is probably due to a combination of causes, some mechanical—as the weight of the limb itself, the centre of gravity of the lower extremity in the recumbent position being (as pointed out by Owen) on the outer side of a line connecting the acetabulum and heel, and others physiological—as the action of the external rotator muscles upon the lower fragment. In a few cases *inversion* has been observed, and is attributed by Mr. Erichsen to paralysis of the external rotator muscles from concomitant injury. Pirrie reports a case in which inversion was accompanied by adduction and great flexion, the deformity thus closely resembling that of dislocation downwards and backwards. (See Chapter XIII.)

In cases of *impacted* fracture, these symptoms are all much less marked, and the *eversion* may be so slight that, as justly remarked by Bigelow, it may be "best indicated by a comparison of the extent to which the two limbs can be *inverted*."

The *diagnosis* between intra- and extra-capsular fracture will be considered when we come to speak of the latter form of injury.

The *prognosis* of unimpacted intra-capsular fracture must always be guarded. Bony union very rarely takes place in these cases, chiefly on account of the deficient vascular supply to the pelvic fragment, and the difficulty, often amounting to impossibility, of keeping the fragments in apposition. Many surgeons, indeed, have doubted whether bony union ever occurs under these circumstances, and those specimens which have been produced as instances of osseous union are all open to the objection that the line of fracture may have been at least partly extra-capsular. In cases of *impacted* intra-capsular fracture, however, bony union may undoubtedly occur.

As these injuries are commonly met with in those of advanced age, the shock and general constitutional disturbance are often considerable; old persons, too, bear confinement badly, and, in such, these injuries not unfrequently prove fatal, through the occurrence of congestion or inflammation of internal organs, the formation of bed-sores, etc. Under more favorable circumstances the patient may recover, union taking place, if at all, by means of fibrous bands, and the limb remaining permanently shortened and lame.

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[1] To determine whether or not the shortening is, in any particular case, in the cervix femoris, Mr. Bryant measures the distance on either side from the trochanter major to a line drawn from the anterior-superior spine of the ilium at right angles to the plane of the body. Dr. Cleemann, of this city, has pointed out that from the shortening of the limb, in these cases, a fold or wrinkle is formed over the ligamentum patellæ, and can be "smoothed out" by making extension.

2. *Extra-capsular Fracture of the Cervix Femoris* is a less common injury than the intra-capsular variety. It is, like the latter, usually, though less exclusively, met with in advanced life,[1] and is generally produced by *direct*, though occasionally by *indirect*, violence, such as a fall on the feet or knees.

The *line* of fracture commonly corresponds with the anterior and posterior inter-trochanteric lines, and the inner almost invariably penetrates the outer fragment, in such a way as to split and comminute it into several portions. Either trochanter may be completely detached, and the fracture may involve the summit of the shaft itself. Occasionally the fracture is completely impacted. The *symptoms* are much the same as those of the intra-capsular form of injury, the chief differences being that the *trochanter* moves in an arc of still shorter radius, that the *pain* is acuter and more superficial, and that the *crepitus* is more distinct, the fragments being sometimes felt loose under the skin; the *shortening* (unless in cases of impaction) is greater at first, but does not undergo much subsequent change, while *eversion* is not so invariably present. As this form of fracture usually results from direct violence, it is commonly attended with great contusion and swelling of the soft parts.

The *differential diagnosis* between intra- and extra-capsular fracture may in many cases be made by attention to the above-mentioned peculiarities, taken in connection with the history of the case, the age of the patient, etc. In cases of *impacted* fracture, the diagnosis is much more difficult, and in such cases the surgeon must be very cautious in his examination, lest he inadvertently remove the impaction, and thus seriously complicate the condition of the patient: for in any fracture about the neck of the femur, impaction is a most desirable circumstance, limiting the amount of shortening, and favoring the occurrence of bony union. *Severe contusion* of the hip may cause temporary eversion and immobility, and thus simulate fracture; if the joint be also the seat of *rheumatoid arthritis*, there will be superadded shortening and false crepitus. The *diagnosis*, under such circumstances, must be made by careful inquiry into the history of the case and the previous condition of the patient.

The *prognosis* of extra-capsular fracture, unless the patient die from shock or general constitutional disturbance, or from some concomitant injury, is usually favorable. Bony union readily occurs in these cases, the amount of callus, on account of the comminution of the fracture, being very large, forming stalactitic projections or *osteophytes*, which are most abundant along the posterior inter-trochanteric line.

3. The neck of the thigh-bone may be broken *partly within* and *partly without* the capsule; the symptoms would, of course, be essentially those of the previously described varieties, and the chances of bony union proportional to the degree in which the fracture was extra-capsular.

4. *Fracture through the Trochanter Major and Base of the Neck.*—The line of fracture in this injury, which is sufficiently described by its name, separates the femur into two segments, the upper of which embraces the head, neck, and trochanter major. The signs of the injury are crepitus, eversion, and shortening of about three-fourths of an inch; bony union readily occurs.

5. *Fracture of the Epiphysis of the Trochanter Major* must be an extremely rare accident, there being, according to Hamilton, but one authentic case on record. The diagnosis, I should suppose, could only be made during life

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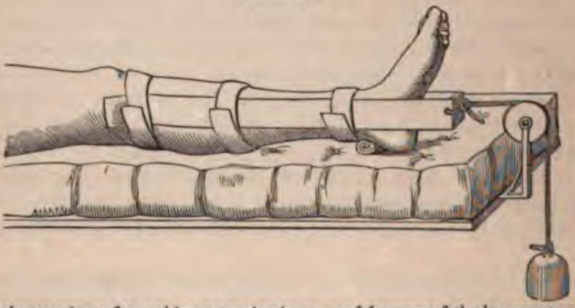
[1] According to Gordon, of Belfast, extra-capsular is more common in *extreme* old age than intra-capsular fracture.

by observing displacement of the epiphysis, *without* the ordinary signs of fractured femur.

Treatment of Fractures of the Upper Extremity of the Femur.—I have no hesitation in expressing my preference for the treatment of these injuries by means of the *straight position with moderate extension,* whenever that mode of treatment is applicable. In cases of *impacted fracture,* extension is (for reasons already indicated) undesirable, and such cases may be treated by position alone, the joint being fixed by means of the long splint, in any of its varieties, or simply supported by means of heavy sand-bags placed on either side of the injured member. If the fracture be *unimpacted,* the same treatment should be employed, with the addition of moderate extension. For this purpose, Liston's splint, or that of Desault (as modified by Physick and others), may be conveniently used; or the surgeon may employ Hagedorn's apparatus, as modified by Gibson, or the less cumbrous contrivances of Gross, Hartshorne, or Horner. The simplest mode of treatment, however, and that which I much prefer, is the old-fashioned weight extension, first popularized in this country by Prof. Gurdon Buck, of New York, with the addition of sand-bags to either side of the limb. *Weight extension* is thus applied: A strip of adhesive plaster (cut lengthwise and well stretched) is prepared, 2½ to 3 inches wide, and 3½ to 4 feet long. On the middle of this is placed a block of wood, of the same width as the adhesive strip, but four inches long, and half an inch thick; over this, again, is placed another adhesive strip of the same width, and 1½ to 2 feet in length; the block, which is sometimes called the *stirrup,* is thus secured in the centre of a long band, of which the upper twelve inches at either end are adhesive. The band is then applied to the leg on which extension is to be practised, so that it adheres on either side from just below the knee to just above the malleolus, the stirrup remaining as a loop about four inches below the sole of the foot (Fig. 127). The apparatus is fixed by two or three broad strips passed circularly around the limb, which is finally surrounded with an ordinary spiral bandage. The malleoli should be protected by a layer of cotton, to prevent excoriation. It is well to allow a short time to elapse before applying the extending force, so that the strips may become firmly adherent. To the stirrup is fixed a cord, which plays over a pulley fixed at the foot of the bed, and which carries the extending weight, which, for fractures of the neck of the femur, need not usually exceed ten or twelve pounds. *Counter-extension* may be made by means of a perineal band, or broad adhesive strips applied to the lower part of the trunk and fastened to the head of the bed, or, which is usually sufficient, simply by elevating the foot of the bed, thus utilizing the weight of the body itself as the counter-extending force. The sand-bags are merely long bags, like

FIG. 127.



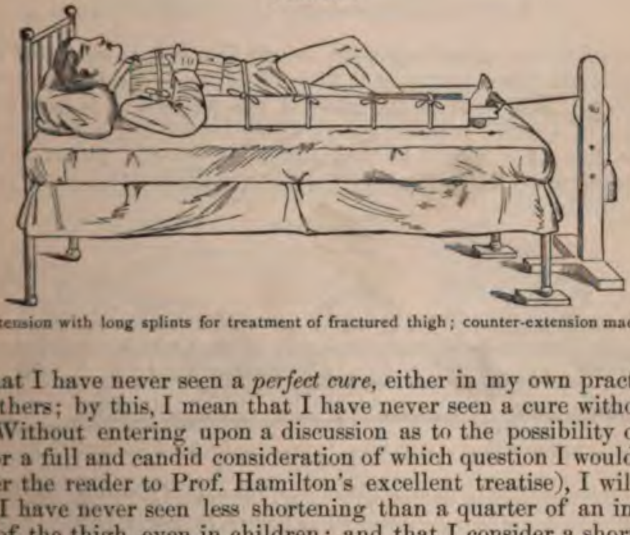
Adhesive plaster stirrup for making extension in cases of fracture of the lower extremity, etc.

the "junks" used with Physick's splint, except that they are filled with clean sand instead of bran: the outer should reach from the axilla to the sole of the foot, and the inner from the perineum to the internal malleolus.

While I have recommended this mode of treatment for every case to which it is applicable, it is but right to say that there are certain cases, especially of intra-capsular fracture in old persons, in which *no apparatus* can be borne, and in which even confinement to bed is fraught with dangerous consequences; under such circumstances, the injured limb should be simply laid across pillows, as recommended by Sir Astley Cooper, until the pain and inflammation which attend the injury have subsided, the patient being then allowed to get up in a chair or on crutches; bony union, under such circumstances, cannot be hoped for, and the *general* rather than the *local* condition of the patient should be the object of attention. In some of these cases, a moulded leather or pasteboard splint, or a plaster-of-Paris bandage, may be used with advantage. Colles, of Dublin, employs a modification of Sayre's apparatus for hip-disease.

2. Fracture of the Shaft of the Femur.—This injury may be met with at any age, and in any part of the bone; it is most frequent, however, in the middle third. The accident commonly results from direct violence, and the direction of the fracture is almost invariably oblique. The fracture is marked by mobility, shortening, eversion, and crepitus, which are so manifest that the nature of the injury can scarcely be mistaken. With regard to the *prognosis* of fracture through the shaft of the femur, I have no hesitation in saying that I have never seen a *perfect cure*, either in my own practice or in that of others; by this, I mean that I have never seen a cure without shortening. Without entering upon a discussion as to the possibility of such a result (for a full and candid consideration of which question I would respectfully refer the reader to Prof. Hamilton's excellent treatise), I will merely say that I have never seen less shortening than a quarter of an inch, after fracture of the thigh, even in children; and that I consider a shortening of from half an inch to an inch, a satisfactory result in adults.[1] The *treatment* of fractures of the shaft of the thigh is most conveniently conducted with the *weight extension* apparatus already described, substituting, however, for the sand-bags, long splints (either padded or provided with bran junks), which have the effect of fixing both the hip- and the knee-joint, a very important

FIG. 128.



Weight extension with long splints for treatment of fractured thigh; counter-extension made by raising foot of bed.

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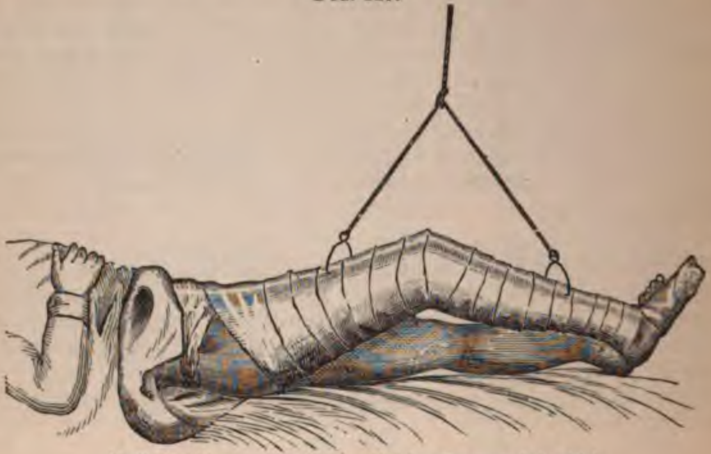
[1] The question of *shortening* in fractured thigh has lost much of its significance since Drs. Cox and Roberts, of this city, and Dr. Wight, of New York, have ascertained by measurement that an inequality in the length of the lower limbs is often congenital.

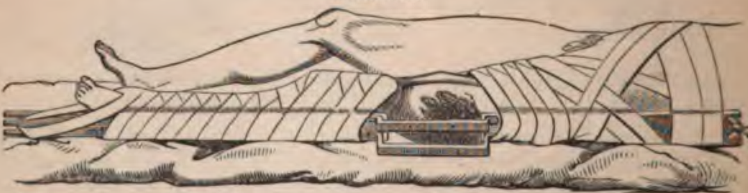
consideration in the management of these injuries. (Fig. 128.) The chest and pelvis should both be secured to the external splint by broad and firm bands, while the splints themselves should be kept in position by similar bands, passing at intervals across the affected limb. In fractures of the upper part of the shaft, there is frequently seen an anterior angular projection, which is generally attributed, and is probably usually due, to the tilting forwards of the lower end of the upper fragment; though that it is occasionally due to the projection of the lower fragment is shown by several specimens described by Mr. Butcher. Whatever be the cause of the projection, it may require the application of a third, anterior splint, which should reach from the groin to above the knee, and should be well padded to prevent excoriation. After several weeks, when union is pretty well advanced, short moulded pasteboard splints may be applied immediately around the seat of fracture, the long splints and weight extension being continued as before, or, instead of the pasteboards, the plaster-of-Paris bandage may be substituted. This is the mode of treatment which I am in the habit of employing in cases of fractured thigh, and I have found it to be as efficient as it is simple. Excellent cures may, however, doubtless be obtained by the use of other means, such as the various forms of apparatus already mentioned (page 264), or the "suspension splints," of Prof. N. R. Smith, of Maryland (Fig. 129), and Prof. J. T. Hodgen, of St. Louis. *Compound Fractures of the Thigh* may be conveniently treated with the weight extension apparatus, with the bracketed long splint (Fig. 130), with a simple long fracture-box (particularly useful when the bran

FIG. 129.



N. R. Smith's anterior splint, applied for a fracture of the thigh.

FIG. 130.



Compound fracture of shaft of thigh-bone; treatment by bracketed long splint. (ERICHSEN.)

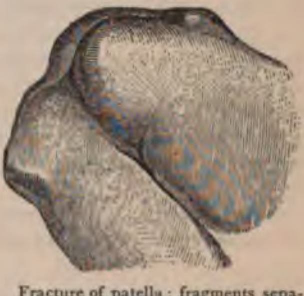
dressing is to be employed), or, in some rare cases, with the old-fashioned double-inclined plane, which was so popular at the end of the last and the beginning of this century.[1]

3. Fracture of the Condyles of the Femur.—Either condyle may be broken off separately, or there may be a splitting fracture between them, complicated with a more or less transverse fracture through their base. The symptoms are mobility, crepitus—elicited by rubbing the condyles together—and, if the fracture extend through their base, shortening; there is also an increase in the breadth of the limb around the condyles, which persists after recovery. These accidents may result from direct violence, or from falls on the knee (the patella, as remarked by Willett, acting as a wedge in splitting the condyles asunder), and are often followed by secondary inflammation of the knee-joint, which may run on to suppurative disorganization, endangering either the limb or life of the patient. The *treatment* consists in placing the limb at rest in a straight or almost straight position, in a long fracture-box with a firm but soft pillow, and in making moderate extension if there be much shortening; recovery will usually be attended with more or less anchylosis. *Separation of the Lower Epiphysis of the Femur* would require the same treatment as fracture of the condyles. *Compound Fracture of the Femur, involving the Knee-joint*, should, almost invariably, be considered a case for amputation.

The time required for the treatment of a fractured thigh may be said to be from eight to ten weeks; even if union appear firm before that time, the patient should not be allowed to bear any weight on the limb, for fear of *consecutive shortening*, which I have known to occur after apparently complete recovery.

Patella.—Fractures of the patella are usually met with in male adults, and are commonly produced by *muscular action*, the patella being broken as an over-bent lever across the condyles of the femur; under such circumstances, the line of fracture is *transverse*, and the upper fragment may be drawn some distance upwards by the powerful muscles of the thigh. The patella is occasionally broken by *direct violence*, when the fracture may be *comminuted* or *longitudinal*. The *diagnosis* is easily made: in transverse fracture there is almost always some displacement, which is increased by flexing the knee;[2] while in comminuted or longitudinal fractures, the nature of the case is rendered evident by the mobility and crepitus, which, under such circumstances, are very distinct. *Inability to walk or stand*, which is often spoken of as a sign of fractured patella, is, as remarked by Gouget, more apparent than real, the patient being able, though not willing, to walk, on account of the pain which attends the effort. The

FIG. 131.



Fracture of patella; fragments separated by flexing the knee.

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[1] I will merely mention, without in any degree commending, the plan proposed by Dr. Hennequin, in an essay which received the *Barbier prize*, that "in fractures of the thigh the limb should be placed in a horizontal plane, in moderate abduction and outward rotation, with the leg flexed at a right angle, and the trunk elevated;" a position which would require the patient to sit on the side of the bed, with his leg hanging over the edge (*Archives Générales de Médicine*, Déc. 1868, pp. 657–662).

[2] T. Curtis Smith, of Ohio, has, however, recorded a case in which the only dis-

prognosis is favorable; though bony union is rarely obtained, especially in the case of transverse fracture, the utility of the limb is not materially impaired, and instances are on record in which patients, after recovery, have engaged in duties requiring great activity and strength of limb, although with a separation of several inches between the fragments of the patella. The *treatment* consists in placing the limb in a straight position, with the leg somewhat elevated, so as to relax the fibres of the quadriceps femoris muscle.[1] The upper fragment of the patella, being drawn downwards, is held in place by means of a firm compress, which is secured by strips of adhesive plaster fastened to a broad posterior splint, provided for the purpose with notches or cross-pieces. The whole limb and splint are then surrounded with a roller, which, by figure of 8 turns around the knee, gives additional security and firmness to the part. The limb should be raised, simply by pillows or by an inclined plane, the relaxation of the quadriceps femoris muscle being further assisted, as recommended by Hamilton, by elevating the patient's trunk. Care must be taken, as with all fractures of the lower extremity, to keep the foot strictly at right angles with the leg, so as to avoid the "pointed toe" deformity which is otherwise apt to ensue. This simple mode of treatment, which is essentially the same as that recommended by Hamilton, is quite as efficient as the more complicated plans devised by Lonsdale, Amesbury, Cooper, Burge, Callender, Beach, and others. Malgaigne's hooks, and their various modifications introduced by Morton, Levis, J. M. White, and others, while doubtless efficient, and probably less dangerous than is usually supposed, are at least unnecessary, and, from their formidable appearance, undesirable. A better mode of treatment, which has been revived by Gibson, of Missouri, Eve, of Tennessee, and Blackman, of Ohio, consists in holding the fragments in apposition by means of an iron ring. Dr. Blackman thus twice succeeded in obtaining bony union. It is certainly a safer plan than that of Volkmann, who by means of a curved needle carries a strong silver wire around and *beneath* the patella, approximating the fragments by tightening the ring thus formed. Many authors advise that no dressings should be employed until the swelling which follows the accident has subsided; but this delay exposes the patient to the risk of permanent shortening of the rectus femoris, and I, therefore, think it better to apply the apparatus at once, though, of course, not too tightly, watching it carefully, and being prepared to loosen it, should the exigencies of the case so require. After recovery, a pasteboard or leather cap should be worn around the joint for some time, until the ligamentous bands which unite the fragments have attained the necessary degree of firmness, to resist any ordinary force to which they may be subjected.

The duration of treatment, in cases of fractured patella, should be about six weeks, the joint being still longer protected with a suitable cap, as already

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placement was a slight anterior projection of the upper fragment, which could not be brought into place except by flexing the knee; in this instance, doubtless, the expansion of the quadriceps femoris tendon, which covers the anterior surface of the patella, remained intact.

[1] According to Hutchinson, this precaution is unnecessary; the separation of the fragments is due, in his opinion, not to the action of the quadriceps femoris, which he believes to be entirely passive, but to fluid pressure from within the joint. (See an able paper in *Med.-Chir. Trans.*, vol. lii. pp. 327–340.) Schede recommends, in these cases, that the joint should be tapped with antiseptic precautions. Cameron, Lister, Uhde, H. Smith, and Rose, reviving a plan adopted many years ago by Rhea Barton, of this city, wire the fragments together (antiseptically), and have thus obtained good results; but subsequent amputation was required in a case under the care of Dr. J. A. Wyeth, of New York, and another case in the same city terminated fatally. Macnamara employs subcutaneous section of the quadriceps femoris muscle and of the ligamentum patellæ.

directed. In any case in which confinement would be inconvenient, a plaster-of-Paris bandage might be used after the first week or two, the patient being then allowed to go about.

Compound Fracture of the Patella, involving, as it usually does, the knee-joint, is commonly considered a case for amputation. The elaborate statistics of Mr. Poland show, however, that this extreme measure is in reality seldom called for; thus, of 68 cases treated without operation, 56 recovered and only 12 died (17.65 per cent.), while of 7 in which amputation was performed, 5 recovered and 2 died (28.57 per cent.), and of 10 treated by excision, only 4 recovered and 6 died (60 per cent.). Of the whole 85 cases, therefore, 65 recovered and 20 died. Suppuration of the joint occurred in 43 of those cases which terminated favorably, and in all of those which proved fatal.[1]

Fractures of the Bones of the Leg.—Either the tibia or fibula, or both, may be broken, the *cause* of these injuries being usually *direct,* though occasionally *indirect violence,* and the line of fracture generally oblique, except in the upper part of the tibia, where it is commonly transverse. If only one bone be broken, there will not be much displacement, the other acting as a splint, except in fractures just above the ankle, when the foot inclines to the injured side. Fracture of both bones, in the middle or lower third, is often attended with considerable displacement, the line of fracture being oblique (from above downwards, forwards, and inwards), and the lower being drawn up behind the upper fragments by the powerful muscles of the calf. The existence of this displacement, together with undue mobility and crepitus,

Fig. 132.

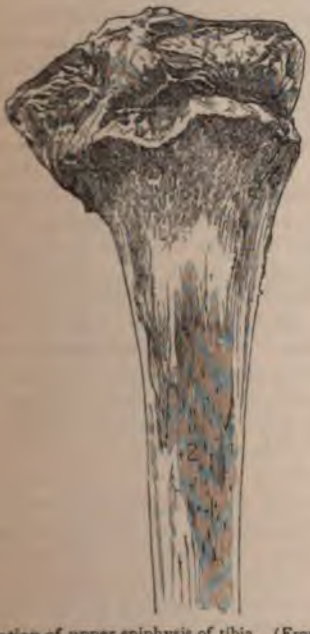
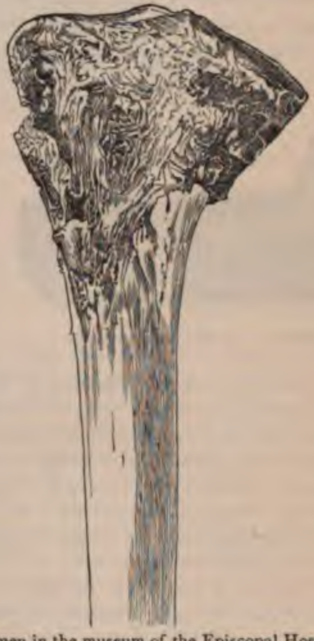


Fig. 133.



Separation of upper epiphysis of tibia. (From a specimen in the museum of the Episcopal Hospital.)

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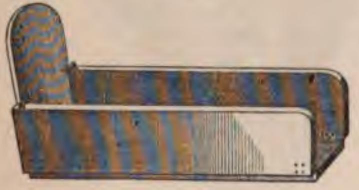
[1] Med.-Chir. Trans., vol. liii., p. 49.

renders the diagnosis easy; and even when one bone only is broken, the nature of the case can be readily ascertained by careful examination. A "V-shaped" fracture, occurring at the junction of the middle and lower thirds of the tibia, is described by Gosselin, Hodges, and other writers. Fracture of the upper end of the fibula has been complicated with paralysis of the external muscles of the leg, in cases recorded by Duplay and others.

Separation of the Upper Epiphysis of the Tibia is a very rare accident, there being, indeed, as far as I know, but three instances of it on record; one is mentioned by Mad. Lachappelle, the case being that of a new-born infant, and the injury having been produced during delivery; the second is figured in the last edition of Holmes's *System of Surgery*, from a specimen in the museum of St. George's Hospital; and the third occurred in my own practice, in a boy eleven years old, who was caught between the bumpers of railway cars; the laceration of the soft parts was so great as to require amputation, and the nature of the accident was thus ascertained by dissection; the specimen from which the illustrations (Figs. 132, 133) are taken, is now in the museum of the Episcopal Hospital. Dr. Voss, of New York, has recorded a case of separation of the *lower epiphysis*, in which, in spite of the occurrence of necrosis, recovery with a useful limb was ultimately obtained.

Treatment.—For the treatment of the great majority of fractures of the leg, whether one or both bones be involved, I know of no apparatus which presents so many advantages as the old-fashioned fracture-box with movable sides (Fig. 134), containing a soft but firm pillow; the fracture having been reduced, the limb is gently laid in the box, the sole of the foot being adjusted to the foot-board, with the heel well brought down, and raised on a pad of cotton or tow placed beneath the tendo Achillis. The foot is then secured by a turn of bandage, and the sides of the box brought up so as to make firm and equable pressure upon the fractured limb. Care must be taken to keep the foot at a right angle with the leg, to prevent eversion of the knee by frequent adjustment,[1] to prevent excoriation of the heel by the use of the pad under the tendo Achillis, and of the malleoli by pads above and below those prominences, and to counteract any tendency to lateral displacement by the use of suitable compresses. By strict attention to these points, I do not hesitate to say that, in the immense majority of cases, as good a cure can be obtained with the simple fracture-box, as with any of the complicated contrivances which the ingenuity of surgeons has suggested. In fact, the chief difficulty with the fracture-box is that it is so simple, that surgeons are apt to think that nothing is required beyond placing the limb in it, and there letting it stay for the requisite number of weeks; and it is, I believe, to the neglect of the surgeon, rather than to any fault of the apparatus, that are to be attributed the bad results on which many modern writers, in objecting to the use of the fracture-box, lay such stress.

FIG. 134.



Fracture-box, with movable sides.

If in cases of very oblique fracture it be desired to make *extension*, this can readily be done by means of the ordinary adhesive-plaster stirrup, pulley, and weight, the extending bands (which, of course, must not be attached above the seat of fracture) being brought through slits in the foot-board of the fracture-box. Certain cases of oblique fracture[1] may be best treated in the flexed position, and a very good apparatus for this purpose is the *anterior splint* of Prof. N. R. Smith, of Maryland (Fig. 129).

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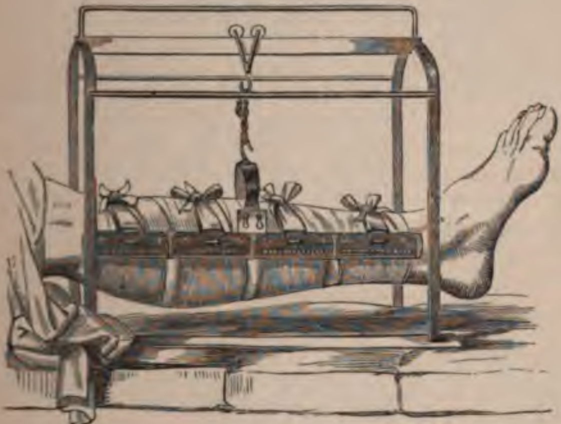
[1] A convenient practical rule is to see at each visit that the *ball of the great toe*, the *inner malleolus*, and the *inner condyle of the femur* are all in the same vertical plane.

The comfort of the patient may often be promoted by *suspending* the fractured limb from a yoke attached to the sides of the bedstead, for which purpose either the ordinary fracture-box, or Salter's swing cradle (Fig. 135), or the "anterior splint," may be conveniently employed.

After three or four weeks, when union is pretty well advanced, the limb may be advantageously surrounded with moulded and well-padded pasteboard splints, being then replaced in the fracture-box; or the plaster-of-Paris bandage may be now safely applied. The treatment of a broken leg usually occupies from six to eight weeks.

FIG. 135.



Salter's cradle.

It is in cases of *compound fracture* of the leg, that the *bran dressing*, introduced by Dr. J. Rhea Barton, of this city, is particularly useful. It is thus applied: inside of an ordinary fracture-box, of suitable size, is placed a sheet of oil-cloth, or India-rubber cloth, and on this a layer of fine and clean bran about two inches deep: the fracture being reduced, the limb is laid in the box, with a pad of cotton beneath the tendo Achillis and around either malleolus, and a layer of the same material around the limb just below the knee; the sides of the box are then brought up and secured, and more bran is dusted and packed around and over the leg till the box is filled, the fractured limb being thus firmly and evenly supported on all sides. The same precautions as to position are to be observed as in the management of a simple fracture, the daily dressing consisting in letting down one or both sides of the box, and, without disturbing the limb, removing the soiled bran with a spatula, and replacing it with fresh material. The great advantages of the bran dressing are its simplicity and cleanliness, the bran readily absorbing all discharges as they are formed, and affording a sure protection against flies; in recent cases, the uniform pressure of the bran has been, moreover, found very efficient in checking hemorrhage.

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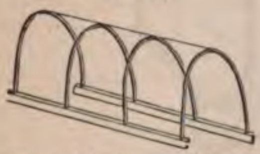
[1] For the treatment of these oblique fractures, Malgaigne recommends an apparatus, provided with a sharp screw to hold the fragments in place; while Laugier, and more recently Mr. Bloxam, recommend division of the tendo Achillis. I have no personal experience with either of these modes of treatment, which, however, I cannot but think unnecessarily severe.

Fracture of the Head of the Tibia into the knee-joint is apt to be complicated with injury of the popliteal vessels (see page 231). For its treatment, a fracture-box, long enough to fit the joint, is employed, such as was recommended for fracture of the condyles of the femur. The injury is often followed by anchylosis.

Fractures about the Ankle are, perhaps, more troublesome than any other fractures of the leg. The fibula alone may be broken, usually giving way about three inches above the joint, or the tip of the inner malleolus may be torn off as well (*Pott's fracture*), or either malleolus may be longitudinally splintered into the ankle-joint (an accident commonly followed by anchylosis), or, finally, the inner malleolus alone may be broken, the fibula escaping. Any of these forms of injury may be safely and conveniently treated with the fracture-box, the deformity being obviated by frequent and careful adjustment and the judicious use of compresses. I have never had occasion to use Dupuytren's splint for fractured fibula, though I doubt not that when carefully applied it is an efficient apparatus. In the management of fractures of the leg, or in fact of any part of the lower extremity, the injured limb should be protected from the weight of the bedclothes by means of a suitable framework of bamboo, wood, or wire, as shown in Fig. 136.

FIG. 136.



Wire rack for fracture of the leg.

In cases of fractured leg occurring in very young children, or in adults suffering from mania a potu, when no restraint can be borne, it is a good plan to surround the broken limb with a soft pillow, which is held in place by means of firm bandages; the part can then be tossed about without risk of further injury.

Fractures of the Bones of the Foot.—The only tarsal bones, the fractures of which require special notice, are the *calcaneum* and *astragalus*.

The Calcaneum may be broken by direct violence, or by muscular action; the line of fracture may assume any direction, and, when the injury results from direct violence, the fracture may be comminuted or impacted. If the tuberosity of the bone only be separated, the fragment may be drawn upwards for a considerable distance by the action of the gastrocnemius muscle, whereas, if the fracture be through the body of the bone, there can be little or no displacement, the fragments being held in place by the lateral ligaments. The treatment, if there be no displacement, consists merely in placing the limb in a fracture-box or on a pillow, and combating inflammation by evaporating lotions, etc., applying subsequently splints or a gypsum bandage. When the posterior fragment is drawn upwards, the foot should be kept in an extended position, so as to relax the gastrocnemius, by means of a well-padded anterior splint, or the apparatus already recommended for rupture of the tendo Achillis (page 211).

The Astragalus is almost invariably broken by the patient falling from a height, alighting on his feet. Simple fracture of this bone is rarely attended with displacement; in fact there are, as far as I know, but two cases of the kind on record, one reported by Dr. Norris, and one by myself.[1] In the former, the displacement was downwards and forwards; in the latter, downwards, outwards, and backwards. The treatment consists in reduction (if practicable), the limb being then placed in a fracture-box, and subsequently dressed with pasteboard splints or a starched bandage. If reduction were impracticable, in a case of simple fracture, I should be disposed to temporize, reserving excision (which is usually recommended under such circumstances) as a secondary operation, to be employed should sloughing or necrosis ensue: in Dr. Norris's case, the displaced fragment was excised by Barton, but amputation was subsequently required, and the patient ultimately died, a year and a half after the occurrence of the accident. Even in fractures unattended with displacement, necrosis may ensue, when secondary excision of the affected portion will be required; in a case of this kind under my care at the Episcopal Hospital, I removed the greater part of the astragalus nearly three months after it was broken, with the happiest results.

In a *Compound Fracture* of the astragalus, if reduction were impracticable, I should advise complete excision, which Rognetta (whose paper on this subject is classical) considers preferable to excision of the displaced fragment only. When, however, such an injury is attended with much comminution, or is complicated with fracture of the malleoli or other tarsal bones, amputation will often be required as a primary operation.

Fractures of the Metatarsal Bones or Toes are usually produced by direct violence, and if attended with much laceration, commonly require amputation. In cases of simple fracture, it will be sufficient, after effecting reduction, to apply a plantar splint, and to place the limb in a fracture-box, the dressing being changed, after a time, for pasteboard splints or a plaster-of-Paris bandage.

CHAPTER XIII.

DISLOCATIONS.

A DISLOCATION or luxation is a displacement, as regards their relative position, of the bones which enter into the formation of a joint. Dislocations are variously classified: thus they are said to be traumatic, pathological or spontaneous, and congenital. *Traumatic* dislocations are such as result from the sudden application of force; *pathological* or *spontaneous* luxations are such as occur from an alteration in a joint as the result of disease (as in the dislocation of the femur in hip-disease), or simply from a paralyzed condition of the muscles around the joint, without any evidence of disease of the articulation itself; while *congenital* dislocations are, as the name implies, such as exist at the moment of birth, being usually due to original malformation of the parts concerned. When the term dislocation or luxation is used alone, it is generally understood to mean one of the *traumatic*, or, as Hamilton calls it, *accidental* variety. When dislocation occurs in the form of joint designated by anatomists as "*amphiarthrosis*" or "mixed articulation," it is sometimes called *diastasis*, as in the separations between the first and second bones of the sternum, between the vertebræ, or at the pubic or sacro-iliac symphysis.

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[1] Amer. Journal of Med. Sciences, April, 1862, pp. 335–340.

Dislocations are further classified as *complete* or *partial;* as *simple, compound,* or *complicated;* as *recent* or *old;* and as *primitive* or *consecutive.*

In a *complete* dislocation, the bones which enter into the formation of the joint are entirely separated from each other; in a *partial* or *incomplete* luxation (also called a *subluxation*), the articulating surfaces remain in contact, through a portion of their extent. The terms *simple, compound,* and *complicated,* bear the same relative meanings as when applied to fractures. *Compound* luxations may be made so directly by the luxating force, or may become so through rupture of the overstretched soft parts which surround the dislocated joint. Among the most serious *complications* of a luxation may be mentioned fracture of either of the articulating surfaces of the injured joint, and rupture of the main artery of the limb, as of the popliteal in backward dislocation of the knee. A *recent* dislocation is one in which time has not been afforded for the production of inflammatory changes in the articulating surfaces and surrounding tissues, or at least not to such a degree as seriously to impede reduction; an *old* dislocation being, of course, one in which sufficient time has elapsed to permit such changes to occur. A *primitive* luxation is one in which the displaced bone remains in the position into which it was first thrown by the luxating force. A *consecutive* dislocation is one in which the displaced bone has secondarily changed its position, either under a continuance of the influence of the luxating force, or as the result of subsequent muscular contraction, or of the surgeon's manipulations in an attempt to effect reduction.

Causes of Dislocation.—*Age* and *Sex* are *Predisposing Causes* of dislocation, only as far as they influence the exposure of the individual to external violence; thus these accidents are rare in infancy and in old age, being usually met with in those in active adult life, and much more frequently in men than in women. More important predisposing causes are the *anatomical relations* of the joint, and the *condition of the neighboring muscles and ligaments;* thus the ball-and-socket joints are more liable to luxation than the ginglymoid, while persons of vigorous muscular frame are less exposed to these injuries than those whose tissues are relaxed and feeble. The following table, compiled from Malgaigne's statistics, shows the relative frequency with which various parts are dislocated:

	Cases.		Cases.		Cases.
Jaw	7	Elbow	45	Femur	40
Vertebræ	4	Radius	7	Patella	2
Pelvis	1	Wrist	16	Knee	9
Clavicle	42	Thumb	20	Ankle	31
Humerus	370	Fingers	7	Metatarsus	2

Atrophy and *paralysis* of a limb predispose it to dislocation, as do likewise *stretching and relaxation of ligaments* from articular effusion, or from previous dislocation, ulceration, etc.

The *Exciting Causes* of dislocation are *external violence,* direct or indirect, and *muscular action.* The latter is the more usual agent in the production of *pathological dislocations,* when it acts slowly and gradually; *traumatic* luxations are also, however, traceable to the effect of muscular action, especially when the joint has been previously weakened by any of the causes above mentioned; thus cases are recorded by Cooper, Haynes, Bigelow, and others, in which patients possessed the power of producing dislocation by a voluntary effort, and I have myself seen such a case in the person of an epileptic woman, who was in the habit of dislocating her hip in the public streets, as a means of exciting sympathy.

Symptoms and Diagnosis of Dislocation.—The usual signs of dislocation are: (1) a change in the shape of the joint and in the relative position of the articulating surfaces, the extremity of the displaced bone being often felt in an abnormal position; (2) an alteration in the length of the limb, either shortening or elongation; and (3) unnatural immobility of the affected joint. The first is the only symptom which can be considered essential, for in partial luxations (as of the elbow) there may be neither lengthening nor shortening, and if the articular ligaments be extensively lacerated, there may be a positive increase instead of diminution of mobility. From a fracture in the neighborhood of a joint, a dislocation may usually be distinguished by observing the *immobility* (when that is present), the *absence of crepitus*, and the fact that the *displacement when removed by reduction does not return*. *True crepitus* does not exist in a case of pure dislocation; there is, however, a rasping or crackling sound, due to effusion or inflammatory changes in the articular structures, which is commonly developed in the course of two or three days, and which may readily be mistaken for the crepitus of a fracture in which the process of repair has already begun. Again, while *displacement* does not always recur in cases of fracture, it may recur in a case of dislocation, if there be much laceration of the ligamentous tissues, or if the articular surfaces themselves have undergone structural changes from inflammatory action; thus in old luxations of the hip it is often easier to effect than to maintain reduction. Hence no one of these symptoms can be considered as in itself pathognomonic, and it is found in practice that the most experienced surgeon is occasionally liable to err in the diagnosis between luxation and articular fracture.

Dislocation, like fracture, is commonly accompanied by *pain*, *swelling*, and *ecchymosis*; wide-spread *extravasation* may occur from rupture of vessels, and *paralysis* (temporary or permanent), or *neuralgia*, from compression or laceration of neighboring nerves.

Articular Changes Produced by Dislocation.—The immediate effects of a dislocation consist of a rupture more or less extensive of the capsular ligament, with or without laceration of the other ligaments of the joint, and of neighboring tendons, muscles, vessels, and nerves; in cases of dislocation from muscular action, however, the capsular ligament may be merely stretched, without rupture. If the luxation be promptly reduced, the lacerated structures are gradually restored to their normal condition, though the joint is often left permanently weakened, and paralysis or neuralgia may continue for an indefinite period. If reduction be not effected, the articular surfaces themselves undergo changes. In a ball-and-socket joint, the old cavity becomes filled up, and its margins absorbed and flattened, while a new socket is commonly formed around the head of the dislocated bone, which changes its shape, and becomes gradually accommodated to its new position; if, however, the head of the bone rests upon muscle, instead of a new socket being formed, the soft tissues undergo condensation, forming a cup-shaped cavity of fibrous structure, which becomes attached by its margins to the displaced bone, and is lubricated by a synovia-like fluid. In the hinge-joints similar changes occur, the osseous prominences being rounded off, and the displaced bones gradually accommodating themselves more or less perfectly to their new positions. These changes, which occur with comparative rapidity in childhood, take place very slowly in adult life, often occupying several years in their completion. At the same time, the surrounding muscles and tendons become shortened and atrophied, and abnormal adhesions often form between the displaced bones and neighboring nervous and vascular trunks—

a circumstance which has several times been the cause of fatal hemorrhage in attempts to reduce old dislocations.

Prognosis.—In some cases, beyond a temporary stiffness and weakness of the part, a dislocation appears to entail no unpleasant consequences; but in the majority of instances, a limb which has been the seat of luxation will not be completely restored for months or even years, or occasionally during the whole lifetime of the patient. An *unreduced* dislocation of course causes permanent disability, and yet it is surprising to what an extent the displaced parts accommodate themselves to their new positions, the utility of a limb after dislocation being often much greater than would be thought probable in view of its evident deformity; so that it is sometimes a question, in cases of old dislocation, whether reduction would be desirable, if even it could be accomplished.

Treatment.—The indications for treatment in any case of dislocation may be said to be to effect reduction, to put the joint in such a condition that the natural process of repair may take place without undue inflammation, and to encourage the restoration of the functions of the part.

Reduction.—This should be effected, in every case, at the earliest possible moment. While I have advised that in certain cases of suspected fracture, minute examination should be delayed until after the subsidence of swelling, the case meanwhile being treated as one of fracture, in a case of suspected dislocation no such temporizing course would be justifiable, for the reason that while reduction in a recent case is usually quite easy, a very short delay will render it difficult, and in some cases almost impossible. Hence, if the nature of the case be not perfectly clear, the surgeon should not hesitate to employ anæsthesia as an aid to diagnosis, more particularly as the use of the anæsthetic will greatly facilitate reduction, should the existence of a dislocation be determined.

The principal obstacles to reduction, in any case of luxation, are muscular resistance and the anatomical relations of the joint. There are three distinct elements to be considered in estimating the influence of the muscles in hindering reduction; these are, (1) the *passive* force which the muscles possess in common with the other soft structures of the body, and which is brought out by the stretching of their tissues across the displaced bony prominences; (2) the *active* force, whereby the patient *voluntarily* though *unconsciously* resists the surgeon's efforts at reduction; and (3) a state of *reflex tonic contraction* into which the muscles are thrown as the result of the traumatic irritation, produced by the injury itself; this, which is the most important form in which muscular resistance is manifested, is more and more fully developed as the luxation remains longer unreduced. It often happens that if a patient is seen immediately upon the occurrence of a dislocation, the muscular relaxation, due to the general state of shock which accompanies the accident, is so great, that the displacement can be reduced with the greatest facility, and, indeed, is often so reduced by the bystanders or by the patient himself. The knowledge of this fact led surgeons, before the discovery of anæsthetics, to prepare patients for the reduction of luxations by the use of the warm bath, the administration of tartar emetic, and even general bleeding. To obviate the unconscious though voluntary resistance of the patient, the older surgeons laid stress upon the importance of *surprising the muscles,* as it were, by diverting the patient's mind, by asking a sudden question, or making an unexpected remark, at the moment of attempting reduction. The tonic, reflex contraction of the muscles may be overcome, to a certain extent, by the use of opium, especially by the hypodermic method, or, as was done by

Physick, by inducing intoxication; but a more efficient and trustworthy plan than any of these, and the only one which is habitually resorted to at the present day, is the administration of ether or chloroform, so as to produce anæsthesia and complete muscular relaxation. Anæsthetics are indeed invaluable in the treatment of dislocations, occurring in vigorous adults; but in cases met with in children, or in adults of feeble and relaxed muscular frame, reduction should be attempted, and may often be conveniently effected, without anæsthesia.

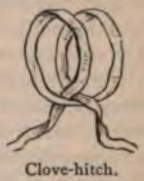
Muscular resistance having been overcome, all that the surgeon has to contend with, in a case of recent dislocation, is the hindrance to reduction presented by the anatomical structure of the joint, the shape and altered relations of the articular surfaces themselves, and the condition of the capsular and other ligaments which in a state of health keep the bones in apposition. Hence the paramount importance of an accurate knowledge of anatomy, in undertaking the treatment of these cases; as Prof. Hamilton well observes, in a very large majority of instances force and perseverance will finally succeed, by whomsoever they may be employed, but they succeed at the expense of great suffering, and perhaps permanent injury to the patient. It is the mark of the skilful surgeon not to employ blind force, but to adapt his manipulations to the exigencies of the case, gently eluding the resistance to his efforts, and making the ligaments, muscles, and bones themselves act as efficient mechanical powers under his intelligent guidance.

In the immense majority of cases, at least of recent dislocation, reduction can be effected without the use of greater force than can be applied simply through the hands of the surgeon and his assistants. The *processes* by which reduction is effected, are three in number, viz., manipulation, extension and counter-extension, and direct pressure.

1. *Manipulation.*—This term is used in a technical sense to describe certain movements by which the surgeon aims to effect reduction by utilizing the structural elements of the joint itself.

2. *Extension and Counter-extension.*—Here the proximal articular surface is fixed by the knee or heel of the operator, by the hands of an assistant, or by means of a folded sheet, padded belt, etc., while the *extending force* is applied directly by the surgeon's hands, through the medium of bandages or towels secured with the clove-hitch knot (Fig. 137), or by still more powerful means, such as the compound pulleys (Fig. 157), Fahnestock's and Gilbert's rope windlass (Fig. 155), Bloxam's tourniquet (Fig. 156), or Jarvis's adjuster. *Continuous Elastic Extension*, by means of India-rubber bands, has been utilized by Dr. H. G. Davis, of New York, in the treatment of old dislocations, and by this means Dr. Davis claims to have reduced a dislocation of the hip of fourteen years' standing. Continuous extension as a preliminary to reduction has also been successfully employed by Doutrelepont.

FIG. 137.



Clove-hitch.

3. *Direct Pressure.*—By this alone, or in combination with the other methods, it is often possible to simply push the displaced bone into its normal position.

When *extending bands* are used, great care should be taken to prevent their excoriating the soft parts; for this purpose they should be smoothly and evenly applied, and should be *wet*—a wet bandage being less apt to slip, and producing less friction, than one that is dry. These bands may be applied directly over the displaced bone, or to the furthest extremity of the affected limb; thus, in luxations of the humerus, they may be fixed above the elbow, or around the wrist.

I have already indicated my preference for simple and gentle means of effecting reduction in cases of dislocation, and may add that, in my own practice, I have never had occasion to resort, in recent cases, to anything beyond manipulation, with manual extension and pressure; and though I should be loth to say that more powerful means should never be employed in cases of recent luxation, I cannot help thinking that the pulleys, and even extending lacs, are less often required in the treatment of these injuries than is commonly supposed.

After-treatment.—This consists in placing the joint at complete rest, by the use of suitable bandages and splints, as in cases of fracture; if there be much inflammation, it may be necessary to leave the part exposed, for the application of evaporating lotions or other topical remedies. Opium may be used to relieve pain, and the general condition of the patient should be attended to, laxatives, diaphoretics, etc., being administered, if necessary. To encourage the restoration of function, passive motion should be employed as soon as the inflammatory symptoms have subsided, usually in the course of the second or third week. Loss of tone in the muscles should be combated by the use of friction, electricity, and the cold douche, and by the cautious administration of strychnia.

Compound Dislocation is always a very grave accident; if the wound be small and clean cut, with but little concomitant injury, it is occasionally possible to save the part, by effecting reduction and then treating the case simply as one of wounded joint; but if there be much laceration, and especially if there be a fracture of either or both articular extremities, excision or amputation should be performed, according to the particular joint affected, and the extent of lesion present. As far as any general rule can be given in such cases, it may be said that the surgeon's first thought should be of excision, except in the case of the knee, where amputation is preferable.

Complicated Luxations.—The complication of dislocation with *fracture* has already been considered in Chapter XI. A graver complication is *rupture of the main artery* of the limb. This has occurred in connection with dislocations of the shoulder and of the knee; in the former situation, ligation of the subclavian artery (after reduction), as successfully practised in a case recorded by R. Adams, would be indicated, and in the latter (as a general rule), amputation. The consequence of non-interference would be the formation of a diffused traumatic aneurism, which would prove fatal either by hemorrhage, or by the supervention of gangrene. Extensive extravasation from the rupture of the smaller vessels may, however, occur, and may usually be successfully treated by the enforcement of rest and the use of evaporating lotions. Paralysis from *compression or rupture of nerve trunks* is occasionally met with as a complication of luxation, and is to be treated by the use of friction, electricity, etc.

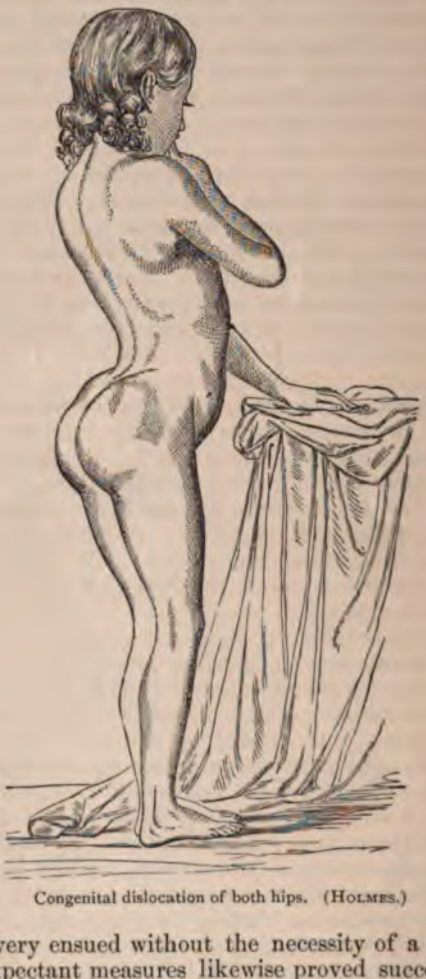
Old Dislocations.—The reduction of old dislocations is attended with more difficulty, and likewise with more risk, than the reduction of recent dislocations. The increased difficulty is due to the permanent contraction and structural changes which occur in the muscles, to the abnormal adhesions which form between the displaced bone and the parts with which it is in contact, and to the changes which have already been described as taking place in the articular surfaces themselves. The increased dangers which attend efforts at reduction in these cases are dependent on the same morbid changes: among the accidents which have occurred under these circumstances may be enumerated laceration of the skin and subcutaneous tissues, rupture of muscles in the neighborhood of the dislocated joint, deep-seated inflammation and suppuration around the joint, rupture of arteries, veins, or nerves, fracture of the displaced bone or of neighboring bones, and finally avulsion of the entire limb, as happened in a remarkable case reported by Guérin. Hence, while greater force is required in the treatment of these cases than in that of recent luxations, the employment of such force is always attended with considerable risk. Even manipulation without extension is not free from danger, for the displaced bone may, in its new position, have acquired adhesions to the main artery or vein, rupture of which, in the action of reduction, would probably cause serious, if not fatal, hemorrhage.

It is impossible to fix any definite period beyond which reduction should not be attempted in cases of old dislocation. Dr. Nathan Smith reduced a luxation of the shoulder nearly a year after the accident, and luxations of the hip have been reduced by Dr. Blackman, and by Dr. Smyth, of New Orleans, at periods respectively of six and nine months after the reception of the injury. Even if the attempt at reduction fail, the surgeon's manipulations, if practised with caution and gentleness, may be of service in increasing the mobility of the limb, and thus adding to its usefulness in its abnormal position. Hence, in the case of dislocation, even of several months' standing, provided that the effort were warranted by the general condition of the patient, I should recommend an attempt at reduction, undertaken, of course, with the extremest caution and delicacy. The patient should be thoroughly relaxed by anæsthesia, and gentle manipulation and moderate extension then employed, so as to stretch or slowly sever any morbid adhesions, and allow the displaced bone to be gradually brought into its proper position; or the elastic extension recommended by Dr. Davis might be resorted to, and would certainly be worthy of a trial in the event of other means failing.

Subcutaneous Division of Muscles, Tendons, and Ligaments, was proposed by Dieffenbach as a preparatory measure in the treatment of old dislocations, and by this plan that surgeon succeeded in effecting reduction in a case of luxation of the humerus of two years' standing. In the hands of others, however, the operation has not been generally successful, while it has occasionally given rise to extensive suppuration and sloughing. Subcutaneous osteotomy has been successfully employed by Dr. Mears, of this city, in a case of irreducible dislocation of the shoulder. Volkmann has successfully excised the head of the femur, with antiseptic precautions, in a case of hip-dislocation of two months' standing.

Treatment of Accidents occurring during Attempts at Reduction of Old Dislocations.—If a *fracture* occur in the effort to reduce an old dislocation, the attempt should be at once discontinued, and the broken bone placed in such a position as to favor union. The *rupture of an important muscle*, such as the pectoralis major, would likewise oblige the surgeon to desist from further efforts at reduction. *Rupture of the main artery*, with formation of a traumatic aneurism, is a very grave accident when occurring under these circumstances; it has been chiefly met with in the case of the axillary artery, in connection with dislocation of the humerus. There are two courses open to the surgeon in dealing with such a case, viz., to ligate the subclavian, or, as has been recently done (unsuccessfully, however) by Callender and Lister, to resort to the "old operation," laying open the sac, and tying the vessel above and below the point of rupture. The latter course would probably be the safest under these circumstances, the case herein differing from one of arterial rupture accompanying *recent dislocation* (see p. 278); there the effect of the "old operation" would be to convert the injury into a compound luxation of the worst kind, whereas in an *old dislocation* the connection with the joint would be less direct (from the effects of inflammatory action), and the prospects of the operation proportionably better. Ligation of the subclavian has been resorted to four times under these circumstances, by Warren, Gibson, Nélaton, and R. Adams, the first and the last mentioned cases having terminated successfully. In a similar case Blackman tied the axillary artery in its upper portion, but the patient died on the eleventh day from hemorrhage, and Maunder speaks of nine similar operations of which only one was successful. Amputation at the shoulder-joint proved fatal in a case recorded by Mr. Bellamy. Rupture of the axillary *vein* terminated fatally in a case recorded by Froriep, but in a similar case in the practice of Agnew, of this city, recovery ensued without the necessity of a resort to operative interference. Expectant measures likewise proved successful in a case recorded by Sands, of New York, in which the axillary artery was supposed to be the vessel implicated. *Avulsion of the limb,* as occurred in Guérin's case, would, of course, require immediate amputation.

FIG. 138.



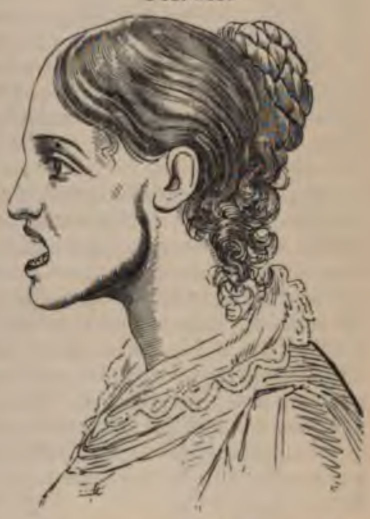
Congenital dislocation of both hips. (HOLMES.)

Spontaneous, Pathological, and Congenital Dislocations.—In the treatment of these cases there is usually not so much difficulty in *effecting*, as in *maintaining* reduction. Guérin, Brodhurst, and others, have successfully employed subcutaneous tenotomy and myotomy, followed by continued extension, in the treatment of congenital luxations, and the same treatment might be adopted in cases of the pathological variety, provided that no active joint disease were present at the time of operation. In cases dependent on muscular paralysis, the difficulty would be in maintaining reduction, and here external support (in the form of carved or moulded splints, elastic bandages, or some of the ingenious devices which are used in the treatment of deformities, and which will be hereafter alluded to) might be usefully employed. Congenital dislocation of both hips is well shown in Fig. 138.

SPECIAL DISLOCATIONS.

Dislocation of the Lower Jaw is a rare accident, occurring chiefly in early adult age, and rather oftener in women than in men. It is usually *double* or *bilateral*, though occasionally one side only is displaced. The most common cause of dislocated jaw is muscular action, though it may also result from a blow on the chin while the mouth is open, or from other forms of violence, such as the forcible introduction of a foreign body into the mouth, or the extraction of teeth. When the mouth is opened, the maxillary condyles ride forwards upon the articular eminences of the temporal bones, and a very slight degree of force is then necessary to make them slip still further forwards into the zygomatic fossæ, thus producing dislocation. The contraction of the external pterygoid muscles, and perhaps of some fibres of the masseters, is thus quite sufficient to produce luxation when the mouth is widely opened, the tonic contraction of the same muscles, combined with the position of the coronoid processes (which catch against the malar bones), being the principal obstacles to reduction. J. W. Hamilton, of Ohio, describes a spontaneous, *backward* dislocation of the lower jaw.

FIG. 139.



Double dislocation of the inferior maxilla.

Symptoms.—The symptoms of a recent dislocation of the jaw are sufficiently obvious. There is prominence of the chin, the mouth being widely open, and the jaw almost immovable; there is likewise a marked depression over the seat of the articulation, with a slight fulness anteriorly. In unilateral dislocation the jaw usually inclines to the opposite side—a symptom which serves for the diagnosis between luxation and fracture, but which, according to Hey and R. Smith, is not always present. There is generally, but not always, pain; the patient speaks and swallows with difficulty; and there is a constant flow of saliva from the mouth.

Prognosis.—Even if the dislocated jaw be unreduced, the patient gradually acquires considerable use of the part, and is ultimately able to close the mouth, chew, swallow, and talk—much less inconvenience being felt from the displacement than would at first be supposed. Reduction in a recent case is easily accomplished, and has even been effected (by Donovan) more than three months after the reception of the injury. Sometimes the ligaments are left permanently weakened, motion of the part being painful, and the joint being liable to a reproduction of the dislocation.

Treatment.—Reduction is effected by disengaging the coronoid processes from the malar bones, and the condyles from the zygomatic fossæ, by pressing the chin upwards, while a fulcrum is placed upon or behind the molar teeth. The surgeon, standing behind the patient, whose head is supported on the operator's chest, may use his thumbs (protected by a piece of leather or folded towel) as a fulcrum, pressing the angles of the jaw downwards, while he elevates the chin with his fingers; or pieces of cork or wood may be used as a fulcrum, in which case they should be provided with strings to facilitate their withdrawal. Nélaton recommends simply pushing the coronoid processes backwards with the thumbs, applied either from within the mouth, or from without. In any case of difficulty, one side might be reduced at a time, taking care while manipulating the second, not to reproduce the luxation of the first. Anæsthesia is not usually required in these cases, though there would be no particular objection to its employment, if it were thought desirable. After reduction, the part should be supported for at least a week or ten days, by means of a four-tailed sling or other suitable bandage.

Subluxation of the Jaw.—Under this name, Sir Astley Cooper has described a peculiar condition, met with chiefly in those of relaxed and feeble muscular frame, which is supposed to depend on the condyles slipping in front of the inter-articular cartilages, and thus rendering the jaw temporarily immovable. Whatever be the true nature of this affection, it is undoubtedly accompanied by relaxation of the articular ligaments, which allow the condyles to slip about during the act of chewing, thus often producing a clacking sound, which is sometimes audible at a distance. The subluxation, if such it be, may be bilateral, or unilateral only; it is sometimes produced by the act of opening the mouth widely, as in gaping or laughing, but, in other cases, occurs without any apparent exciting cause; it may usually be *reduced* by the patient himself, by pressing the jaw sideways, or by lifting the chin slightly upwards. Sometimes this condition appears to depend on spasm of the muscles of mastication, when it may be made to disappear by friction over the affected part. Tonics should be given, if the general condition of the patient appears to indicate their use, and the recurrence of the displacement may be prevented by wearing a sling, held in place by elastic bands.

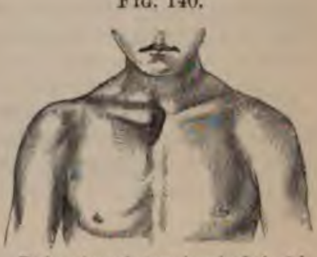
Hyoid Bone.—Cases of dislocation of this bone have been recorded by Dr. Ripley, of South Carolina, and by Dr. Gibb, of London: the *treatment* consists in throwing back the head, depressing the lower jaw, and pushing the luxated bone into position.

Ribs, Sternum, and Pelvis.—Dislocations of the *Ribs* are described as occurring either at their vertebral articulations, or at the junction of their costal cartilages. The symptoms would be much the same as those of fracture in the same localities, except that, of course, crepitus would be wanting. The *treatment* would be the same as for fracture. Dislocations, or rather diastases of the *Sternum* and *Pelvis*, were referred to in connection with fractures of those parts. Salleron has reported three cases of dislocation of the ilium at the sacro-iliac joint, without fracture, in each of which reduction was readily accomplished, and was followed by complete recovery. Gallez has met with disastasis of the pubic symphysis as the result of muscular action.

Clavicle.—The clavicle is more frequently dislocated at the acromial than at the sternal end, the former injury occurring, according to Hamilton, about four times as often as the latter.

Dislocation of the Sternal End of the Clavicle usually results from indirect violence, and is almost always in a *forward* direction. Dislocation *backwards*, however, occasionally occurs, and sometimes gives rise to troublesome dyspnœa or dysphagia, from pressure on the trachea or œsophagus, or to cerebral congestion, from pressure on the cervical veins. Dyspnœa and dysphagia may also occur in instances of *upward* dislocation, of which rare injury R. W. Smith has been able to collect but eight cases, including one observed by himself, to which, however, may be added four others since recorded by Bryant and Shaw. The diagnosis of these cases is usually easy, the subcutaneous position of the clavicle rendering the deformity very apparent. *Reduction* can commonly be effected without much difficulty, by placing the knee against the spine, and drawing the shoulders outwards and backwards, but the displacement is exceedingly apt to be reproduced. The apparatus most generally applicable, consists in a compress over the projecting end of the clavicle (in cases of forward or upward displacement), held in position by adhesive strips, or by an elastic band passing under the groin and perineum, the shoulder and arm being fixed as in a case of fractured clavicle. In case of backward dislocation, the compress should be omitted, the shoulders being simply drawn backwards by a figure of 8 bandage, or some similar contrivance. Though the deformity in these cases (especially when the displacement is forwards or upwards) is seldom entirely overcome, yet the utility of the limb does not appear to be materially diminished by the accident. In one or two cases of backward dislocation, the pressure effects have been so serious as to induce the surgeons in attendance to resort to excision of the displaced portions of bone.

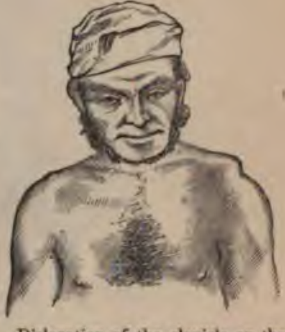
Fig. 140.



Dislocation of sternal end of clavicle, forwards. (Bryant.)

The Outer End of the Clavicle is usually dislocated in an *upward* direction, resting upon the margin of the acromion process; the accident results from indirect violence, and the nature of the case is usually apparent, though, if there be much swelling, it may be mistaken for a downward dislocation of the humerus. Occasionally the acromial end of the clavicle is displaced *downwards*, by direct violence, such as the kick of a horse; and dislocation *under the coracoid process* has been described, though the cases on record are somewhat apocryphal. An instance of *backward* dislocation is recorded by Nicaise. Dislocation of the acromial end of the clavicle may be commonly *reduced* without much trouble, though, as in the case of luxation of the sternal end, reduction can with difficulty be maintained. The after-treatment is the same as for fractured clavicle, with the addition of a firm compress, held in place by broad adhesive strips passing from the point of injury to the elbow: although the deformity can be seldom entirely removed, the motions of the limb are less interfered with than might

Fig. 141.



Dislocation of the clavicle on the acromion. (Bryant.)

be anticipated. Dr. Montgomery, of Rochester, has reported a case successfully treated by Moore's method for fractured clavicle, and a somewhat similar plan has been advantageously adopted by Dr. Doughty, of Georgia.

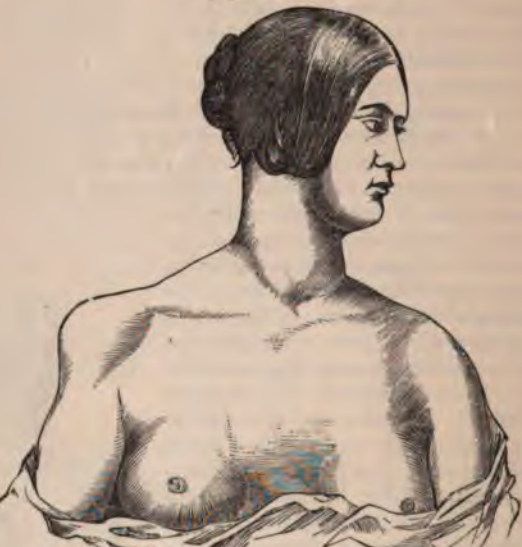
Simultaneous Dislocations of Both Ends of the Clavicle have been observed by Richerand, Gerdy, Morel-Lavallé, Col, S. Haynes, Lund, and North, of Brooklyn, N. Y.

Scapula.—Under the name of dislocation of the scapula, systematic writers describe a projection of the inferior angle of this bone, due either to its escape from beneath the edge of the latissimus dorsi muscle, or to great relaxation of the fibres of that muscle or of the serratus magnus; the symptoms consist in the deformity, which is obvious, with some pain and weakness of the corresponding upper extremity. The *treatment* would consist in the application of external support, with the administration of tonics, and, perhaps, the endermic use of strychnia, as recommended by Erichsen.

Dislocations of the Shoulder.—The head of the humerus may be dislocated *downwards, forwards* or *backwards.*

Dislocation Downwards, or into the axilla (*Subglenoid Dislocation*), is usually due to direct violence, such as a blow on the upper and outer part of the humerus, though it is occasionally caused by indirect force, such as a fall on the hand or elbow, the arm being abducted at the moment of injury. In other cases the dislocation is produced by muscular action, the head of the bone being, as it were, *pulled* out of its socket. In this dislocation, the head of the bone rests below and slightly in front of the glenoid cavity of the scapula, being pressed forwards by the tendon of the triceps muscle; the capsular ligament is widely torn, the long head of the biceps often ruptured or detached, and the supra- and infra-spinatus, subscapularis, coraco-brachialis and deltoid muscles much stretched and sometimes lacerated, while

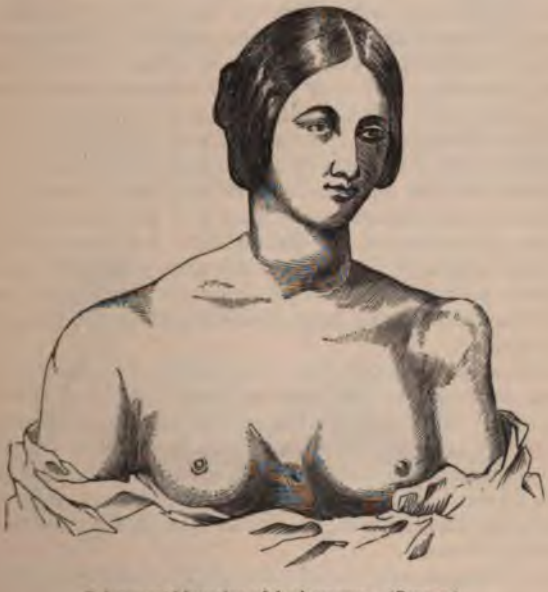
Fig. 142.



Dislocation of the humerus downwards, into the axilla; subglenoid. (Pirrie.)

the axillary vessels and nerves are compressed. The *symptoms*, in a recent case, are usually obvious: there is, beneath the acromion process, a marked depression, which can commonly be seen as well as felt, the arm is lengthened by nearly an inch, and the head of the humerus can be felt in the axilla, especially when the elbow is lifted away from the body. The arm is kept somewhat abducted, and pain is developed by pressing the elbow to the side; the hand cannot be placed on the opposite shoulder when the elbow is in contact with the chest. The *diagnosis* in a recent case is thus usually very easy, but when swelling and inflammation have occurred, it becomes more difficult, if not occasionally impossible, to be again simplified upon the subsidence of the inflammatory condition. Hence, although by a careful and systematic examination, the true nature of the injury may almost always be eventually determined, the surgeon should hesitate before criticizing another practitioner for a mistake which may have been unavoidable under different circumstances. Prof. Dugas, of Georgia, has proposed as a test of the existence of dislocation that the fingers of the injured limb should be placed upon the sound shoulder, and an attempt then made to bring the elbow into contact with the thorax; if this can be done, no dislocation, according to Prof. Dugas, can be present; while, if it cannot be done, he considers the existence of dislocation established, no other injury of the shoulder being capable of causing this disability. The *prognosis* should be somewhat guarded: although reduction is usually effected without difficulty, yet the arm not unfrequently remains permanently weakened, partially anchylosed, or paralyzed from injury to the axillary plexus of nerves. A certain degree of deformity may also remain in spite of reduction, the head of the humerus projecting anteriorly, probably on account of displacement or rupture of the long head of the biceps muscle. The laceration and stretching of the capsular ligament leave the joint predisposed to a recurrence of the dislocation.

FIG. 143.



Subcoracoid luxation of the humerus. (PIRRIE.)

Dislocation Forwards.—Of this form of dislocation there are two varieties, the *Subcoracoid* (Fig. 143) and the *Subclavicular:* the latter may be considered as an aggravated condition of the former, which was, indeed, described by Sir Astley Cooper as a partial luxation. As the names imply, the head of the humerus, in these injuries, rests beneath the coracoid process, or beneath the middle of the clavicle. These luxations, which more often result from indirect than from direct violence, are accompanied by a great deal of muscular and ligamentous laceration, and are attended with even more pain than the dislocation into the axilla. The symptoms are much the same as those of the downward luxation, except that the axis of the arm is even more altered, and that the head of the bone can be felt in a different position. The subcoracoid is more often met with than the subclavicular dislocation, and is said by Mr. Flower and others to be the most common form of luxation of the shoulder-joint. Reduction appears to be more difficult in cases of forward than of downward dislocation; at least there are, according to Hamilton, proportionably more cases recorded of unreduced luxation of the former than of the latter injury.

Dislocation Backwards (*Subspinous Luxation*) is a rare accident, there being probably not more than twenty or thirty cases of it on record; it is usually caused by indirect violence or by muscular action, and differs in its symptoms from the dislocations already described, in that the elbow is brought forwards, instead of backwards, while the head of the bone can be felt more or less distinctly beneath the spine of the scapula. The most striking deformity is the prominence of the coracoid process of the scapula, which seems to project forward, and over which the skin is tightly stretched. Reduction has usually been effected without much difficulty in these cases, but in one instance, mentioned by Cooper, it was impossible to maintain the reduction, on account of rupture of the subscapularis muscle. I have seen but one example of this rare form of injury, and in that, in spite of the marked deformity, the nature of the case had not been suspected for six weeks after the occurrence of the dislocation. I succeeded in effecting reduction without difficulty by raising the arm above the head, and then bringing it down with a broad sweep behind the level of the patient's body, so as to throw the head of the bone forwards, while the scapula was firmly fixed by an assistant.

Partial Dislocation.—Under this name has been described an injury, which appears to consist in a rupture or displacement of the long head of the biceps muscle,[1] allowing the head of the humerus to project anteriorly, rather than in any positive luxation of the bone itself. As already mentioned, this condition occasionally remains after the reduction of an ordinary downward or forward dislocation. Le Gros Clark has reported a case of partial *backward* dislocation which resulted from injury, and in which reduction was readily effected.

Treatment of Dislocations of the Shoulder.—The *subglenoid* and the *subcoracoid* dislocations may be reduced by the same means, while the *subspinous* and *subclavian* varieties require slight modifications in the direction in which the force is applied. Thus, in applying extension in the luxation beneath the clavicle, the head of the bone should be first drawn downwards, outwards, and subsequently backwards, so as to clear the coracoid process; while in the subspinous dislocation, extension should be made downwards, outwards, and subsequently forwards. A great many different plans have been devised for the reduction of dislocations of the shoulder, but they may all be classified in four divisions, as aiming to effect their object: 1, by extension and counter-extension alone; 2, by leverage alone; 3, by a combination of these methods; and, 4, by manipulation, in its technical sense (see page 277).

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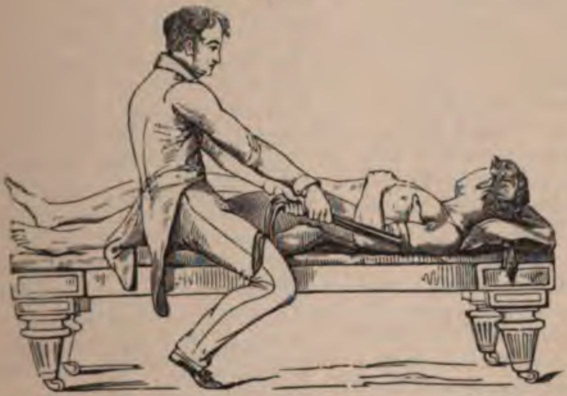
[1] This inward displacement of the biceps tendon, which Soden and others have considered traumatic, is believed by Canton to be due to the existence of chronic rheumatic arthritis, which may or may not have been the result of injury.

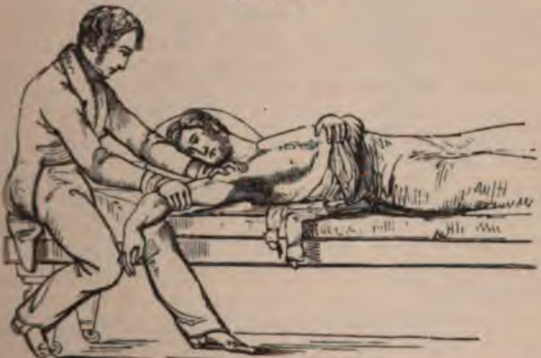
1. *Extension* may be made (1) more or less *downwards*, as in Cooper's method (Fig. 144), in which *counter-extension* is made by the heel in the axilla;[1] as in Skey's method, in which the heel is replaced by an iron knob; or as in Hamilton's plan, in which the scapula is fixed by the ball of the foot, placed against the acromion process; (2) it may be made *outwards*, as recommended by Malgaigne; or (3) it may be made *upwards*, as directed by White, of Manchester, Mothe, and others, the scapula being then fixed by the foot or hand placed above the acromion process. The latter, though painful, is probably the most efficient of any of the methods which profess-

FIG. 144.



Sir Astley Cooper's method of applying extension with the heel in the axilla.

FIG. 145.



Reduction of dislocated shoulder by White's and Mothe's method.

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[1] T. Smith has recorded a case in which, in attempting to reduce a recent dislocation with the heel in the axilla, the anterior axillary fold was completely torn through; the case terminated fatally.

edly act by extension and counter-extension alone. When extension is made with the heel in the axilla, an assistant may give aid by drawing the arm outwards, as advised by Ward, of Dublin.

2. *Leverage.*—The arm may be simply used as a lever, to pry the head of the bone into its place over a fulcrum placed in the armpit, as in Sir Astley Cooper's method with the knee in the axilla.

3. *Extension and leverage combined* are, I think, more effectual than either method separately. The plan which I am in the habit of employing, in these cases, is essentially that which was described by Dupuytren as a modification of Mothe's method, and which, according to Bromfeild, was in common use in his day; it consists in placing the patient, thoroughly etherized, if necessary, in a supine position, and then, having drawn the arm directly upwards, bringing it down fully extended in a broad sweep over an assistant's fist, placed in the axilla to act as a fulcrum—the scapula being at the same time steadied from above by the assistant's other hand. By this plan I have succeeded in reducing dislocations of the shoulder which had defied prolonged efforts made in other ways, and, indeed, have as yet never failed in effecting reduction in a recent case. The same principle, that of extension combined with leverage, is involved in the methods recommended by Sir William Fergusson and by Prof. N. R. Smith, of Maryland, in which, however, the force is applied through the medium of extending lacs or bands. The peculiarity of Prof. Smith's method is that counter-extension is made from the opposite wrist, so as to insure the fixation of the scapula, by provoking the contraction of the trapezii muscles.

4. *Manipulation.*—The reduction of dislocations of the humerus by manipulation alone has been practised by various surgeons, among whom may be mentioned La Cour and Sir Philip Crampton, but the credit of reducing the plan to a system, and of prominently bringing it to the notice of the profession, in this country at least, is, I believe, due to Prof. H. H. Smith, of this city, whose method consists in first converting the luxation (if it be either forwards or backwards) into the ordinary downward or subglenoid variety, and then proceeding as follows: "Elevate the elbow and arm as high as possible, and flex the forearm at right angles with the arm, thus relaxing the supra-spinatus muscle. Then using the forearm as a lever, rotate the head of the humerus upward and forward, so as to relax the infra-spinatus, carrying the rotation as far as possible, or until resisted by the action of the subscapularis muscle, keeping the forearm for a few seconds in its position with the palm of the hand looking upward; then bring the elbow promptly but steadily down to the side, carrying the elbow towards the body, and keeping the forearm so that the palm of the hand yet looks to the surgeon. Then quickly but gently rotate the head of the humerus upward and outward by carrying the palm of the hand downward and across the patient's body, and the bone will usually be replaced."[1]

In cases of old dislocation, Callender recommends, in order to avoid injuring the axillary vessels, to raise the elbow across the chest, and then force the raised arm outwards, rotating and somewhat depressing the arm while so doing. The reduction of shoulder dislocations by manipulation has also been illustrated by Dr. A. Gordon, of Belfast. Kuhn, of Elbeuf, suggests, on account of the difficulty of fixing the scapula, that the *humerus* should be firmly held by an assistant, while the surgeon applies his manipulations directly to the former bone. Dr. Mears's successful osteotomy for old dislocation of the shoulder has already been referred to.

After reduction, the arm should be fastened to the side and supported with a sling, for a week or ten days, so as to allow time for repair of the lacerated ligaments.

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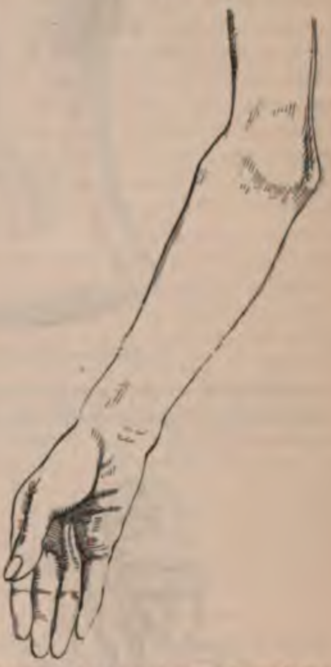
[1] Packard's Minor Surgery, p. 204.

Dislocations of the Elbow.—Both bones of the forearm may be dislocated at the elbow-joint, or either separately. The *Head of the Radius alone* may be displaced forwards, outwards, or backwards, the forward dislocation being much the most frequent, and the cause of the injury being usually a fall on the hand, though the luxation may occasionally result from muscular action. The head of the bone can ordinarily be felt in its abnormal position, and the diagnosis can thus, unless there be much swelling, be readily made. The forearm is kept in a semi-flexed position, and either pronated, or midway between pronation and supination; any motion of the part is attended with great pain. *Reduction* is to be effected by making extension and counter-extension in the direction in which the limb is found, the displaced bone being at the same time firmly pressed into its proper position; the arm should subsequently be fixed on an angular splint, with a compress over the head of the radius. It is always difficult to maintain reduction in these cases, and reduction itself is occasionally impossible; fortunately, the usefulness of the limb does not appear to be materially impaired by the persistence of the displacement.

FIG. 146.



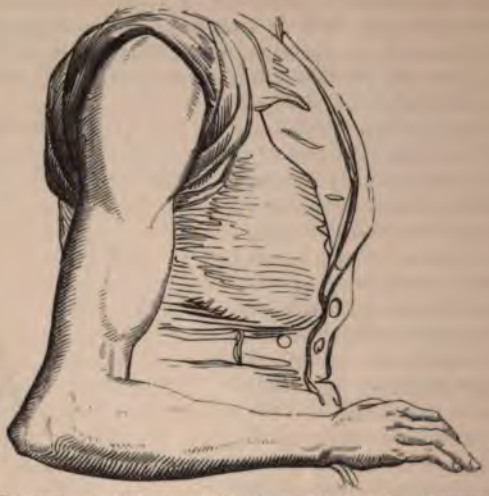
Dislocation of head of radius forwards; external appearance of limb. (LISTON.)

The *Ulna alone* may be displaced backwards, as the result of a fall on the hand, the olecranon then projecting behind the condyles of the humerus, while the head of the radius can be felt in its proper position. The elbow in such a case will be flexed at a right angle, and the forearm twisted inwards and pronated. *Reduction* may be effected by Sir Astley Cooper's method of flexing the elbow over the knee; by extension and counter-extension, combined with direct pressure upon the olecranon; or (as recently recommended by Dr. Waterman, of Boston) by extending the forearm on the arm beyond a straight line, thus using the ulna as a lever of the second order (the olecranon being the fulcrum), to bring the coronoid process over the condyles, into its proper place.

Both Bones of the Forearm may be dislocated at the elbow, *backwards, to either side*, or *forwards*. The dislocation *backwards*, which is the most common, is usually caused by indirect violence, though occasionally by a direct blow, or by muscular action. Not only are the bones displaced backwards, but they are drawn *upwards* by the powerful action of the triceps muscle. The diagnosis, if swelling have not occurred, can usually be made without difficulty; the arm is held in a slightly flexed position (rarely at a right angle), and the slightest attempt at motion causes great pain; the olecranon and head of the radius can be felt projecting backwards, while the condyles of the humerus form a hard and broad prominence on the front of the arm.

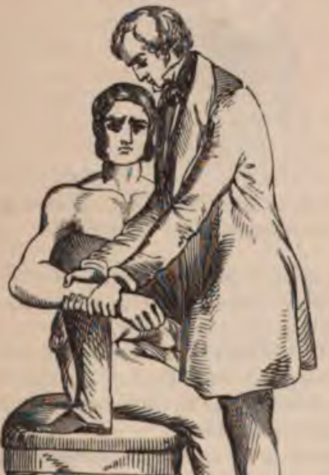
The relative position of the olecranon and condyles is markedly altered, this being an important diagnostic mark between dislocation and fracture. Reduction in a recent case is usually easy, though instances are on record in which failure has attended the efforts of the most skilful surgeons; the prognosis is decidedly unfavorable as regards old dislocations, though reduction has been several times effected at as late a period as six months after the reception of the injury.

FIG. 147.



Dislocation of both bones of the forearm backwards. (LISTON.)

FIG. 148.



Reduction with the knee in the bend of the elbow.

The usual method of *treatment* is that recommended by Sir Astley Cooper, which consists in forcibly but slowly bending the arm over the knee, which is placed on the inner side of the elbow, so as to press on the radius and ulna, separating them from the humerus, and thus freeing the coronoid process from its abnormal position (Fig. 148). Another plan is to forcibly *extend* the arm so as to relax the triceps, making counter-extension against the scapula (as advised by Liston and Miller); or the luxation may be reduced by simple extension (Skey), or by extension combined with direct pressure on the olecranon, according to the plan of Pirrie. In a child, or in a person of feeble muscular development, reduction can usually be effected without the aid of anæsthesia; prolonged efforts at reduction are, however, so painful, that in any case of difficulty an anæsthetic should be employed. Sayre, of New York, has reported two cases of old dislocation of the elbow in which reduction was greatly facilitated by subcutaneous division of the triceps tendon. Hamilton recommends, as a test for reduction, to flex the elbow to a right angle; if this can be done without much pain, it proves that reduction is complete. McGraw advises that in old backward dislocations, in children, forced and extreme flexion should be made, so as to fracture either the olecranon or the lower epiphysis of the humerus, either of which occurrences, he believes, would improve the condition of the joint.

Lateral dislocation of the radius and ulna at the elbow is rarely *complete*, but in the majority of cases is partial, and in an outward direction. The cause is usually direct violence. The deformity in these cases is usually so marked and peculiar as to render the nature of the lesion unmistakable, although I have reduced an inward luxation of two weeks' standing which was at first attended with so much swelling that the gentleman in attendance did not recognize the existence of the injury; *reduction* may be effected by making moderate extension, with direct pressure on the displaced bones, and counter-pressure on the lower end of the humerus. Lateral dislocation is sometimes found coexisting with the ordinary backward displacement; in dealing with such an injury, the lateral luxation should be first reduced, and the case then treated as one of simple backward dislocation. *Osteoplastic resection*, or temporary separation of the olecranon, is recommended by Võlker as a means of exposing the joint in cases of irreducible luxation.

Luxation forwards of both bones of the forearm, without fracture of the olecranon, is a very rare accident, there being not more than six or seven well-authenticated cases on record. The injury appears usually to have resulted from direct violence, and the most striking symptom is elongation of the forearm, which is in a state of supination, the elbow being fixed at a right angle. Reduction may be accomplished by making forced flexion, together with extension and counter-extension, the muscles being relaxed by the use of an anæsthetic. In a case recorded by Dr. Forbes, of this city, reduction was effected by simply flexing the forearm, and then pressing it downwards and backwards. If the luxation were incomplete, the forearm making an obtuse angle only with the arm, reduction might be accomplished by making forcible extension.

Dislocations at the Wrist.—*The Lower End of the Ulna* may be dislocated from the radius, either *forwards*, *backwards*, or *inwards*. These accidents, of which Tillmans, of Leipsic, has been able to collect but 48 cases, are usually caused by muscular action, the dislocation forwards being due to violent supination, and that in a backward direction to violent pronation. The inward is the rarest form of luxation, Tillmans's figures giving but 9 cases of this, as compared with 16 of the forward, and 18 of the backward variety, with 5 in which the direction of the displacement was not specified. *Reduction* is easily effected by fixing the radius, and simply pushing the ulna back into place, the limb being then placed between anterior and posterior splints. In connection with fracture of the lower end of the radius, the backward dislocation of the ulna is not uncommon. The ligaments sometimes remain permanently stretched after the accident, so as to allow a certain amount of mobility of the ulna, and I have known such a condition to be mistaken for ununited fracture of this bone.

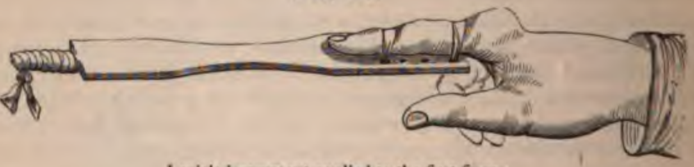
The *Carpus* may be dislocated upon the bones of the forearm, either *backwards* or *forwards*. These injuries are, however, rarely met with—Tillmans has collected but 24 cases—and in every case that has been submitted to the test of dissection, the luxation has, according to Hamilton, been found complicated with fracture. The usual cause of either form of dislocation is a fall on the palm, though in a case of backward displacement recorded by Hamilton, the injury resulted from a fall on the back of the hand, the wrist being strongly flexed. The diagnosis is made by observing the abruptness of the angle made by the displaced bones, their relation to the styloid processes, and (if the case be not complicated with fracture) the absence of crepitus. *Reduction* is easily effected by extension and pressure, and there is subsequently no tendency to reproduction of the displacement.

Individual Bones of the Carpus are occasionally luxated in a *backward* direction, those bones which have been found thus displaced being the os magnum, semilunare, and pisiform, to which some writers add the cuneiform and unciform. The *treatment* would consist in effecting reduction by extension and pressure, supporting the part afterwards with splints and compresses. Chisholm reports a case of *forward* luxation of the semilunare, in which excision of the displaced bone was required. Dr. Nancrede has met with a forward subluxation of the scaphoid.

Hands.—The *Metacarpal Bones*, especially those of the thumb, index and middle finger, may be dislocated upon the carpus, the two latter bones backwards, and the metacarpal of the thumb either backwards or forwards. *Reduction* is effected by extension and pressure, the hand being afterwards secured to a straight splint with compresses.

The *Fingers* may be dislocated at the metacarpo-phalangeal, or, more rarely, at the inter-phalangeal joints. The *proximal phalanx of the thumb* is not unfrequently dislocated *backwards*, reduction being sometimes very difficult, owing, probably, to the head of the metacarpal bone being caught either between the lateral ligaments or between the heads of the flexor brevis muscle, or, according to Farabeuf, to the interposition of the external sesamoid bone. In the *treatment* of these luxations, extension may be made with the ordinary clove-hitch, or with Dr. Levis's ingenious apparatus, or with the "Indian puzzle," as recommended by Prof. Hamilton and others. A better plan, perhaps, is that practised by Prof. Crosby, which consists, according to Gross, "in pushing the phalanx back until it stands perpendicularly on the metacarpal bone, when, by strong pressure against its base, from behind forwards, it is readily carried by flexion into its natural position." In extreme cases subcutaneous division of the resisting ligaments or muscles may possibly be required. *Forward luxation* of the thumb is more rarely met with than the injury last described, and is to be reduced by forcibly flexing the thumb into the palm of the hand. Dislocations of the second phalanx of the thumb, or of the second or third phalanges of the fingers, may be reduced by simple extension and pressure, made with the surgeon's hands, or, if more force be required, with the apparatus of Dr. Levis.

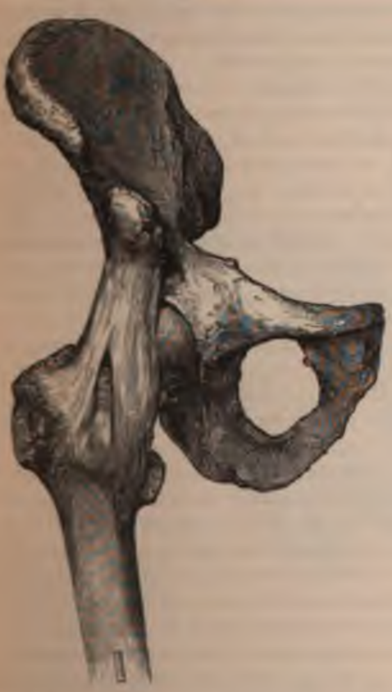
FIG. 149.



Levis's instrument applied to the first finger.

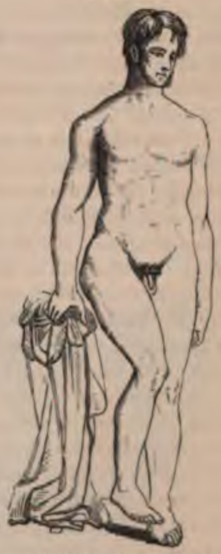
Dislocations of the Hip.—The subject of dislocation of the hip has been most ably investigated by Prof. Bigelow, of Boston, of whose excellent monograph on the subject I shall not hesitate to make free use in the following pages. To understand the pathology of these dislocations, and the mechanism of their reduction, it is necessary to turn for a few minutes to consider the anatomy of the joint, and especially of thát portion of the capsule which is known as the ilio-femoral ligament, or ligament of Bertin, and for which Bigelow proposes the name of "**Y** ligament." This ligament "is more or less adherent to the acetabular prominence and to the neck of the femur; but it will be found, upon examination, to take its origin from the anterior inferior spinous process of the ilium, passing downward to the front of the femur, to be inserted fan-shaped into nearly the whole of the oblique 'spiral' line which connects the two trochanters in front—being about half an inch wide at its upper or iliac origin, and but little less than two inches and a half wide at its fan-like femoral insertion. Here it is bifurcated, having two principal fasciculi, one being inserted into the upper extremity of the anterior inter-trochanteric line, and the other into the lower part of the same line, about half an inch in front of the small trochanter." Both of these divergent branches remain unruptured in the ordinary dislocations of the hip, and their attachments must be borne in mind in attempting reduction of the various forms of displacement.

FIG. 150.



The **Y** ligament; the inner fasciculus is known as the ilio-femoral ligament, or ligament of Bertin. (BIGELOW).

FIG. 151.



Backward dislocation of hip; external appearances.

The head of the femur may be dislocated in almost any direction; but there are three forms of luxation which occur so much oftener than the others as to be usually classed as *regular dislocations*, the other varieties being called *irregular* or *anomalous*. The regular dislocations are—1, *backwards*; 2, *downwards*; and 3, *upwards*.

1. The *Dislocation Backwards*, or *Ilio-sciatic Luxation*, presents two principal varieties, viz., *upwards and backwards* or on the dorsum ilii, and *backwards* only, the dislocation into the ischiatic notch of Sir Astley Cooper, or,

which is a better name, *dorsal below the tendon* (of the obturator internus), according to Prof. Bigelow. These two forms of luxation, taken together, probably embrace more than three-fourths of the whole number of cases, Prof. Hamilton having found that of 104 cases, 55 were on the dorsum ilii, and 28 into the ischiatic notch. These injuries usually result from indirect violence: thus, the dislocation on the dorsum may be caused by any force which produces great adduction, or adduction with inversion, the head of the bone being driven at the same time upwards and backwards. A fall on the outside of the knee, or on the foot, while the limb is adducted,[1] or a severe blow on the pelvis, while the body is bent forwards, may each in turn be a cause of this dislocation. The etiology of the ischiatic form of luxation is much the same, except that it is more apt to occur when the thigh is flexed at a right angle upon the body, the force then driving the head of the bone more directly backwards, than backwards and upwards. The *symptoms* of these forms of dislocation are usually well marked. There is *shortening* of the affected limb, varying from about half an inch in the dislocation below the tendon, to one, two, or even three inches in that on the dorsum ilii. In the first-named variety, the shortening, is, as pointed out by Allis, much more apparent when the limbs are flexed to a right angle than when they are extended. *Inversion* is present in both varieties, though most marked in the ordinary dorsal luxation. The hip itself is *altered in shape*, the trochanter being unduly prominent, and thrown forwards, while the head of the femur can often be felt rotating in its abnormal position. The *axis of the limb* is distorted, the thigh of the affected side crossing the other at its lower third in the dorsal dislocation, and just above the knee in the ischiatic variety;[2] in the former case the foot of the affected limb rests on the instep of the sound side; in the latter, upon the ball of the great toe.

The *diagnosis* has to be made from sprain and from fracture. From *sprain*, the case can be distinguished by careful examination and measurement, the patient being etherized so as to obviate spasmodic muscular resistance. If the limb can be readily everted, the case is not one of luxation. From ordinary *non-impacted fracture*, a dislocation can be distinguished by the fact that in the *former* there is mobility, crepitus, and eversion; in the *latter*, immobility, no crepitus, and inversion. From the rare cases of *impacted fracture with inversion*, the diagnosis is more difficult, but may be made by observing that in such cases the trochanter is flattened, and the head of the bone still rotates in the socket, while in *dislocation* the trochanter is unduly prominent, and the head of the bone can be felt beneath the gluteal muscles. A convenient mode of measurement, which bears the name of Nélaton, consists in drawing a line from the anterior iliac spine to the tuber ischii; in a normal limb, the trochanter lies immediately below this line, but in any case of dislocation will be of course displaced in one or another direction.

Reduction of Backward Dislocations.—The capsular ligament is usually widely lacerated in these injuries, except at its anterior part, where it is reinforced by what has already been described as the **Y** ligament. The ligamentum teres, also, is usually, though not necessarily, torn in these dislocations. The attachments of the Y ligament are such that extension in the line of the axis of the body can only effect reduction by violent stretching or rupture of that ligament; hence, the first step in any rational method of treatment, consists in *flexing the thigh upon the pelvis, so as to relax the ilio-femoral or Y ligament.* The acknowledged difficulty which attends reduction of the ischiatic variety of this luxation is due (as shown by Bigelow), not to the head of the bone being lodged in the sciatic notch, but to its being fixed behind and below the tendon of the obturator internus muscle, which separates it from the acetabulum, and which renders reduction by extension in the line of the body almost impossible. By flexing the thigh on the pelvis, the head of the femur is unlocked from the grasp of the obturator tendon, and the luxation is then as easily reducible as one on the dorsum ilii; or, in case of difficulty, the limb may be flexed over a pad placed as a *fulcrum* in the groin, as advised by Dr. Sutton. The Y ligament being relaxed by flexing the thigh on the pelvis, the dislocation may be occasionally reduced by simply lifting or pushing the head of the thigh-bone into the socket, the rent in the capsular ligament being, if necessary, enlarged by circumducting the flexed thigh across the abdomen, and thus making the head of the bone sweep across the posterior aspect of the capsule. It will usually be better, however, to employ *manipulation* (see page 277), which, though practised empirically in these cases for a great many years previously, was first reduced to a system by Drs. Nathan Smith, of New Haven, and Reid, of Rochester. In the form of dislocation now under consideration, the manipulation necessary for reduction consists (1) in flexing the leg upon the thigh (to gain leverage), and the thigh upon the pelvis (to relax the Y ligament, and, in the case of an ischiatic luxation, to disengage the head of the femur from the obturator tendon); (2) in abducting and at the same time rotating outwards the thigh in a broad sweep across the abdomen; and (3) in finally

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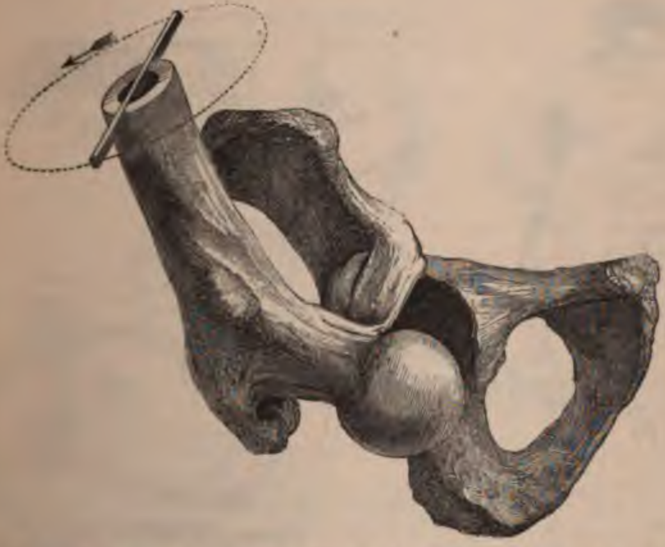
[1] Fabbri, Coote, and H. Morris teach that all dislocations of the hip occur while the limb is *abducted*, the downward luxation being the primary, and the others consecutive displacements; this is, however, denied by F. S. Eve, of St. Bartholomew's Hospital.

[2] According to Bigelow, in the ischiatic variety (dorsal below the tendon), the axis of the luxated limb is more changed than in the ordinary dorsal variety, crossing the sound limb sometimes at a point as high as the middle of the thigh. The fact appears to be that the distortion varies according to the position of the head of the bone at the moment of examination, these varieties of dislocation being readily interchangeable, and the exact position of the bone differing in different cases.

FIG. 152.

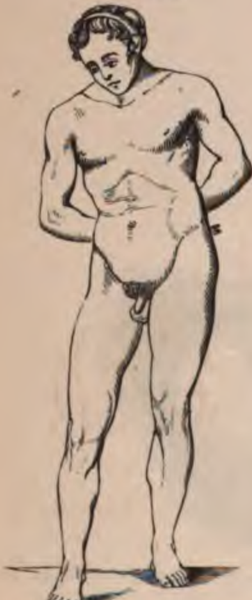


Backward dislocation; reduction by rotation; the limb has been flexed and abducted, and it remains only to evert it, and render the outer branch of the Y ligament tense by rotation. (BIGELOW.)

bringing down the limb into its natural position. The process, in fact, embraces the three motions of flexion, outward circumduction, and outward rotation. The mechanism of this mode of reduction is that, by the abduction and rotation, the outer branch of the Y ligament is made to wind around the neck of the femur, thus constituting a sliding fulcrum by means of which the head of the bone is lifted into the acetabulum.

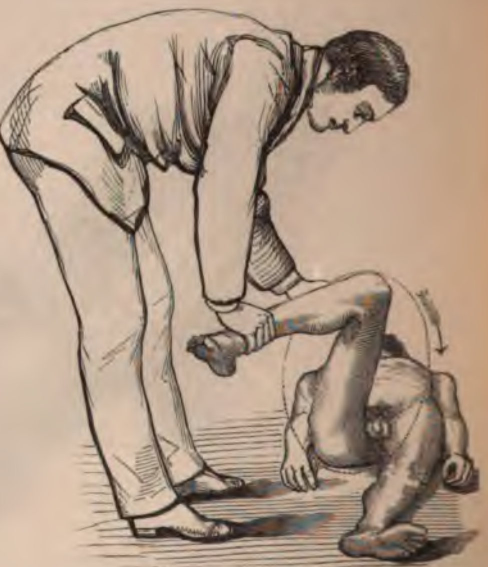
In executing this manœuvre, care must be taken not to flex the thigh too much, or the Y ligament will be unduly relaxed, and the effort at reduction will fail; and not to abduct the limb too widely, or the posterior part of the capsule will be unnecessarily torn, and the head of the bone may slip below the socket on to the thyroid foramen;[1] the angle of extreme flexion should be from 50° to 60°, and that of extreme abduction from 130° to 140°. The first mistake (that of undue flexion) is readily remedied, by repeating the manœuvre with the limb somewhat more extended; to remedy the second error, it is necessary, while making abduction, to *lift* the limb, when the head of the bone will usually slip readily into its socket.

Fig. 153.



External appearances of downward dislocation.

Fig. 154.



Reduction of downward dislocation, by rotation and inward circumduction. (Bigelow.)

2. *Dislocation of the Head of the Femur Downwards*, or downwards and forwards *into the Thyroid Foramen*, is produced by the application of force while the thigh is in a position of abduction, or by a blow on the back of the pelvis while the body is bent and the legs widely apart. The capsular ligament is extensively torn, particularly at its inner and back parts, the round ligament being also ruptured, and the head of the bone lodging usually on the external obturator muscle, over the thyroid foramen. The *symptoms*

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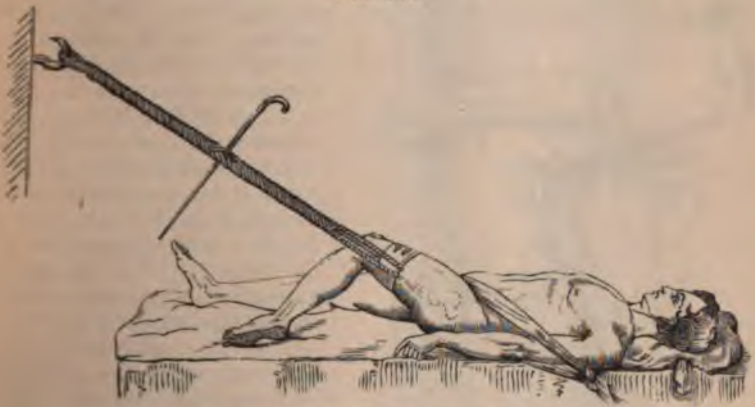
[1] This accident is said by Dr. Erskine Mason, of New York, to occur only when there has been rupture of the obturator internus muscle.

of this dislocation are very apparent: there is commonly an elongation of from half an inch to two inches, though, according to Rivington, there may be no lengthening, or even slight shortening; there is abduction; the leg is advanced, and the foot straight or slightly everted; the trochanter is depressed, and, in a thin person, the head of the bone may be felt in its abnormal situation.

Reduction is effected by a process exactly the reverse of that recommended for the backward dislocations; the leg and thigh being flexed as before, the limb is brought up in a position of *abduction*, then adducted and rotated inwards[1] in a broad sweep across the abdomen (Fig. 154), the *inner branch* of the **Y** ligament being in this case the sliding fulcrum by which the bone is lifted into its socket. Care must be taken, in this manœuvre, to avoid excessive flexion, and excessive adduction, which would throw the head of the bone past the acetabulum, on to the dorsum ilii. The manipulation may be sometimes assisted by drawing the upper part of the thigh outwards with a towel.

Fig. 155.



Application of the rope windlass, for backward dislocation.

3. *Dislocation Upwards*, or upwards and forwards *on the Pubis*, usually results from indirect violence, such as falling on the foot while the leg is stretched backwards, or stepping into a hole while walking, the foot being arrested while the body goes forwards; it may also result from a blow or fall on the pelvis. In this luxation, the head of the femur rests on or above the pubis, being closely embraced by the inner branch of the **Y** ligament. The *symptoms* are shortening, abduction, great eversion, slight flexion (or, more rarely, extension), with great depression of the trochanter, and prominence of the head of the bone, which may be felt over the body of the pubis, and outside of the femoral vessels. The *diagnosis* from fracture is made by observing the absence of crepitus, the immobility, the impossibility, or at least great difficulty, of inverting the limb, and the presence of the head of the bone in its new position.

Reduction may be accomplished, according to Prof. Bigelow, "by much the same method as in the thyroid dislocation, except that in the pubic luxation the flexed limb should be carried across the sound thigh at a higher point. First, semi-flex the thigh, to relax the **Y** ligament, at the same time drawing the head of the bone down from the pubis. Then semi-abduct and rotate inward, to disengage the bone completely. Lastly, while rotating inward and still drawing on the thigh, carry the knee inward and downward to its place by the side of its fellow. As in the thyroid luxation, this manœuvre guides the head of the bone to its socket by a rotation which winds up and shortens the ligament, enabling the operator, by depressing the knee, to pry the head of the bone into its place." As in the case of the thyroid luxation, this manipulation may be assisted by drawing the flexed groin directly outwards with a towel. Dr. M. H. Henry has reported a case of pubic dislocation in which reduction was successfully accomplished after twenty-six days.

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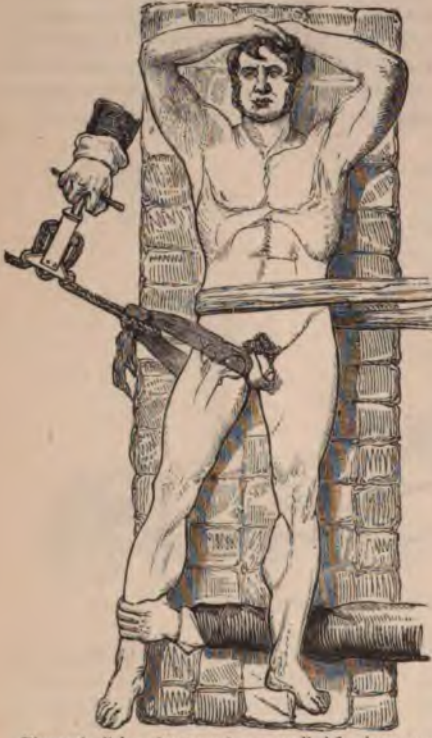
[1] Dr. Markoe, in one case, succeeded in reducing a thyroid luxation by *outward rotation* (using, therefore, the outer branch of the **Y** ligament as a fulcrum), *inward rotation* having previously thrown the head of the bone on to the sciatic notch, from which it was immediately returned to its primitive position; as remarked by Prof. Bigelow, *inward rotation with less extreme flexion* would, probably, have succeeded in the first instance.

Fig. 156.

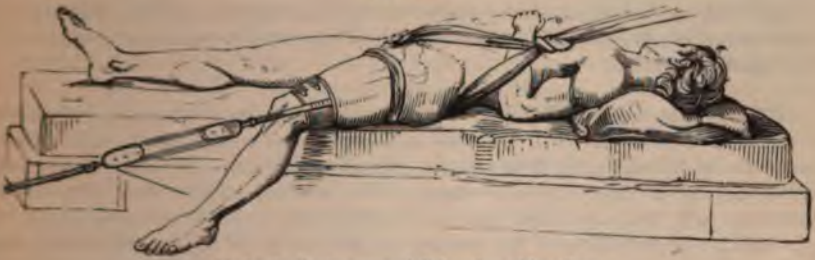


Bloxam's dislocation tourniquet, applied for downward dislocation. (Erichsen.)

I can testify, from my own experience, to the facility with which recent dislocations may be reduced by the methods above described, and believe, with Prof. Bigelow, that the period is not far distant "when longitudinal extension by pulleys to reduce a recent hip luxation will be unheard of." As, therefore, I cannot recommend the use of pulleys in these cases, I forbear to describe their application. Illustrations are, however, given to show the positions in which the pulleys may be applied, and the directions in which extension is to be made, in the various forms of hip luxation, according to the teachings of Sir Astley Cooper and other standard authorities (Figs. 155, 156, 157).

Beside the three *regular* forms of dislocation which have been above described, there are various *anomalous* forms, as (1) *directly upwards* (usually consecutive upon the pubic dislocation), (2) *directly downwards*, between the sciatic notch and the thyroid foramen, (3) *downwards and backwards on to the body of the ischium*, (4) *downwards and backwards into the lesser sciatic notch*, and (5) *downwards, inwards, and forwards* into the perineum. These various forms of downward dislocation may be either primitive or consecutive upon the ordinary thyroid variety. In these irregular forms of dislocation, there is usually great laceration of the capsular ligament, with, in some cases, rupture of the external branch, or even both branches of the **Y** ligament. Reduction may usually be effected by simply flexing the thigh, and then lifting and pushing the displaced bone in the direction of its socket; or the luxation may be converted into one of the "regular" varieties, when manipulation can be applied according to the methods already described. Dislocations of *both* hips have been observed by Gibson, W. Cooper, Boisnot, and Crawford.

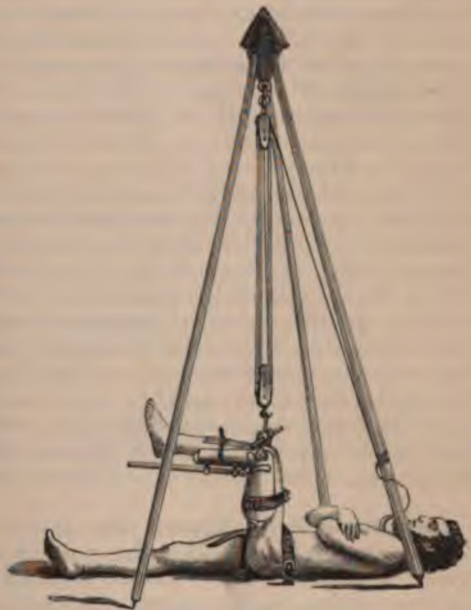
FIG. 157.



Mode of reducing upward dislocation with pulleys.

In cases of *old dislocation* of the hip, greater force may be sometimes required than can be applied by the surgeon's unaided hands, and under such circumstances the apparatus recommended by Prof. Bigelow for effecting *angular extension* may be usefully employed, as was done in a case which I saw with Dr. H. R. Wharton, of this city. The difficulty, however, in these cases, will be often found to be not so much in *effecting*, as in *maintaining* reduction, owing to the structural changes which occur in the acetabulum and head of the femur. To meet this difficulty, Prof. Bigelow suggests that the limb should be fixed in the position in which reduction was effected, until the socket has become again excavated by absorption; the same plan should be adopted in cases of recent luxation, in which there is any tendency to reproduction of the deformity after reduction. MacCormac reports a case of old dislocation of the hip successfully treated by excision.

FIG. 158.



Angular extension, in reduction of old dislocations of the hip. (BIGELOW.)

The complication of dislocation of the hip with fracture of the thigh, should be met by applying firm splints, or Bigelow's "angular extension" apparatus, before attempting manipulation. Should fracture occur during the effort to reduce an old dislocation, the attempts at reduction should be at once abandoned, but advantage might be taken of the accident to obtain union in such a position as would diminish the deformity of the limb.

After reduction of a hip dislocation, it is usually sufficient to tie the knees together with a few turns of a bandage, keeping the patient in bed for a week or ten days. An unreduced dislocation, especially of the ischiatic variety, allows, after a time, much more use of the limb than would at first be supposed possible.

Anæsthesia is almost always required for the reduction of hip dislocations in adults, though in cases of children, or of very feeble persons, it may often be dispensed with.

Dislocations of the Patella.—The patella may be dislocated outwards, inwards, or upwards, or it may be rotated upon its own axis, constituting the vertical luxation of Malgaigne. These accidents may result from muscular action, or from direct violence. The *Outward Dislocation* is the most common, and may be either partial or complete; it may be recognized by the undue prominence of the inner condyle, and by the patella being felt in its new position; the limb is usually slightly flexed. *Reduction* is effected by extending the leg on the thigh, and flexing the latter on the pelvis, so as to relax the quadriceps femoris muscle, when the patella can be easily pushed back into its proper place; Hamilton directs that the patient should be in a sitting posture, the surgeon sitting or standing in front of him, and raising the affected leg upon his own shoulder. If this manœuvre fail, reduction may be accomplished by alternately flexing and extending the knee, while lateral pressure is simultaneously made upon the patella. *Dislocation Inwards* is very seldom met with; its symptoms and treatment are (*mutatis mutandis*) the same as those of the outward variety.

Dislocation of the Patella on its Axis is produced by the same causes as lateral dislocation, of which, indeed, it may be looked upon as an aggravated form; either edge of the patella may project anteriorly, or the bone may be entirely reversed, so that its posterior surface is in front. The leg is usually fully extended, more rarely slightly flexed; the prominence of the patella is so marked as to render any mistake in diagnosis almost impossible. *Reduction* may commonly be effected, as in cases of lateral dislocation, by direct pressure, aided by alternate flexion and extension. A case is recorded by W. F. Marsh Jackson, in which, after the failure of other methods, reduction was readily effected by simply pushing up the displaced bone. It has been proposed to divide the ligamentum patellæ and tendon of the quadriceps extensor muscle, with a view of facilitating reduction in these cases, but the operation does not appear to have been productive of any marked benefit, while in one case it caused fatal suppuration. *Dislocation Upwards* can only result from rupture of the ligamentum patellæ; the treatment would be the same as for fracture of the patella itself.

Dislocations of the Knee.—The *Head of the Tibia* may be dislocated *to either side, forwards, backwards*, or in an intermediate direction, as *backwards and outwards*, etc. These accidents may result from *direct* or from *indirect* violence, such as twisting the thigh upon the leg by stepping into a hole while walking. The *lateral* dislocations are always incomplete, while the antero-posterior luxations may be either complete or partial. The symptoms of these injuries are very obvious; the complete luxations are usually accompanied with shortening. *Reduction* may be effected by forced flexion of the knee, with direct pressure, aided by rocking movements, to which, if there be shortening, extension and counter-extension may be usefully added. The antero-posterior luxations, if complete, are apt to be attended with serious injury to the popliteal vessels and nerves, a complication which may require amputation. After reduction, the limb should be placed at rest in a long fracture-box, or on a suitable splint, until the subsidence of all inflammation of the joint, the part being afterwards protected from sudden motion by the use of an elastic knee-cap or firm bandage. *Compound Dislocation of the Knee* is usually a case for amputation.

Dislocation of the Semilunar Cartilages, or *Internal Derangement of the Knee-joint* (*Subluxation of the Knee*), consists, according to Erichsen, in the semilunar cartilages slipping either forwards or backwards from beneath the condyles of the femur, so that the latter come in direct contact with the articular surface of the tibia, pinching the folds of synovial membrane; most authorities, however, teach that in this accident the cartilages themselves become wedged between the articulating surfaces, in such a way as to impede the motions of the joint, and give rise to the sickening pain which characterizes the injury. The accident is usually caused by twisting the knee, or by tripping over a stone or other obstacle in walking, though it has occurred from simply turning in bed. The symptoms are inability to walk, or even to extend the limb, intense pain, and rapid swelling of the joint. *Reduction* is effected by alternately flexing and extending the knee, combining these movements with slight twisting and rocking of the joint. As the process is painful, ether may appropriately be used in these cases. After reduction, the patient should wear an elastic knee-cap, to prevent recurrence of the displacement.

Dislocation of the Head of the Fibula is a very unusual accident, except as a complication of more serious injuries of the knee. The displacement may be either forwards or backwards, and the subcutaneous position of the bone renders the diagnosis easy. *Reduction* may be effected by extension and direct pressure, or by pressure while the leg is flexed upon the thigh, and a compress and a bandage should be subsequently applied to keep the bone in place.

Dislocations of the Ankle.—These injuries are described by Sir Astley Cooper, Malgaigne, and Hamilton, as *dislocations of the lower end of the tibia:* I think, however, that it is better to speak of them, with Boyer and others, as *dislocations of the foot upon the bones of the leg.* The displacement occurs between the upper articulating surface of the astragalus and those of the tibia and fibula, and the foot may be dislocated *forwards*, *backwards*, to *either side*, or, as in a case mentioned by Druitt, directly *upwards* between the bones of the leg. The *lateral* luxations are usually attended with fracture of one or both malleoli, the *outward* dislocation being sometimes additionally complicated by fracture of the outer edge of the tibia into the joint, a circumstance which, as pointed out by Hamilton, may render reduction impossible. The *backward* dislocation is usually accompanied with fracture of the fibula, and sometimes of the tibia as well. The *forward* dislocation is very rare, usually attended with fracture, and, according to R. W. Smith, always incomplete. These injuries may result from either direct or indirect violence, the particular form of the displacement depending upon the position of the foot at the moment at which the accident occurs. The antero-posterior luxations can be easily recognized by the characteristic deformity, the foot being lengthened in the forward, and shortened in the backward, dislocation. True lateral luxation is a less frequent accident than is generally supposed, the majority of the cases which are called dislocation, being really instances merely of rotation of the astragalus, without actual separation of that bone from the articulating surfaces of the tibia and fibula. *Reduction* may be commonly effected in any of these varieties of luxation, by simple traction (the leg being flexed on the thigh), combined with direct pressure, and flexion and rotation of the ankle in various directions, according to the nature of the displacement; section of the tendo Achillis may occasionally be required. After reduction, the limb should be placed in a fracture-box with suitable compresses, or on a Dupuytren's splint, until recovery is complete.

Compound Dislocation of the Ankle is a very serious accident, and usually requires amputation, particularly when complicated with fracture, though in suitable cases an attempt may be made to save the limb by sawing off the projecting ends of the tibia and fibula. I have once succeeded in effecting a cure without operation, by the continuous employment of irrigation.

Dislocations of the Tarsus.—The *Astragalus* may be dislocated at once from the bones of the leg and from the other tarsal bones, and may be thrust *backwards* (when it projects beneath the tendo Achillis), *forwards and outwards*, or *forwards and inwards*. These injuries result from falls upon the foot, the particular form of the displacement depending upon the position of the foot as regards flexion, abduction, etc., at the moment at which the accident occurs. In the *forward dislocation*, the *leg is shortened*, the astragalus projects in front of one or the other malleolus, and the foot is somewhat extended and twisted to the opposite side. In the *backward luxation*, which occurs least often, the foot is in a state of extreme flexion, and the heel is elongated while the instep is shortened. *Reduction* should be attempted by making firm traction (the leg being flexed upon the thigh), and rotating and twisting the foot in the opposite direction to that in which it is found, while firm pressure is made upon the projecting astragalus. Subcutaneous division of the tendo Achillis has been found a useful adjuvant in cases of forward displacement, and in a case of great difficulty Desault's plan of dividing the attachments of the astragalus itself might be tried, as has been successfully done by Fitzgerald, an Australian surgeon, in a case of five months' standing; or the surgeon might resort at once to excision. I should, however, prefer, in a case of irreducible, *simple dislocation*, to temporize, as advised by Cooper and Broca, reserving excision of the bone as a secondary operation, should sloughing or necrosis render it necessary. *Backward dislocation* of the astragalus is usually irreducible, the patient notwithstanding recovering with a very useful foot. In a case of *compound dislocation*, it would be proper (unless reduction were readily accomplished) to excise the astragalus at once, or to amputate, if the concomitant injuries were so severe as to forbid excision.

Other Dislocations of Tarsal Bones are described, as of the *calcaneum and scaphoid* upon the astragalus, which remains in place below the arch of the malleoli (*subastragaloid* dislocation of Malgaigne); of the *calcaneum* upon the astragalus and cuboid, or upon the astragalus alone; of the *scaphoid and cuboid* upon the calcis and astragalus; or of the *cuboid*, *scaphoid*, or *cuneiform bones*, separately or together.

Reduction in these cases may usually be accomplished by pressure and traction in different directions, according to the nature of the particular displacement. *Forward extension* (that is, at a right angle to the leg) is advised by H. Lee and Pick in the subastragaloid variety. Even if reduction cannot be effected, the limb will often be serviceable in spite of the deformity.

Dislocations of the Metatarsus and Toes are of rare occurrence except as the result of great violence, when amputation will often be required. In cases of simple dislocation, reduction may usually be effected simply by traction and direct pressure, the parts being afterwards fixed with suitable splints and bandages.

CHAPTER XIV.

EFFECTS OF HEAT AND COLD.

Burns and Scalds.

A *Burn* is usually defined as the disorganizing or destructive effect of the application of dry heat or flame, a *Scald* being considered as the corresponding effect of the application of a hot liquid, and it is often said that these two forms of injury may be distinguished by the fact that a *burn* singes the cutaneous hairs, which are, on the other hand, uninjured by a *scald*. It is evident, however, that though this distinction answers well enough for the burns and scalds met with in every-day life, it is not strictly correct; for, in many cases, the two injuries are combined (boiling oil may be at the same time burning oil), and some of the most destructive *burns* are produced by hot liquids—such as molten lead or iron. Again, the injuries produced by caustic acids or alkalies are essentially burns, whether the agent be applied in a liquid or in a solid form.

Effects of Burns and Scalds.—The effects of these injuries are both *local* and *constitutional*. The *Local Effects* vary according to the temperature of the body which inflicts the injury, and the length of time during which its application is continued. Thus a momentary contact with flame will produce a less degree of disorganization than prolonged contact with a substance the temperature of which may be much lower. Dupuytren divided burns into six *classes* or *degrees*, according to the extent of injury inflicted; and this classification, which is in some respects convenient, is still adopted by most surgeons. The *first* class embraces cases of very superficial burn, marked by redness, and followed by desquamation of the cuticle. In the *second* class the injury extends more deeply, and is followed by the formation of numerous vesicles and bullæ. In the *third* class the whole depth of the skin is involved, and is thrown off in the form of thin superficial sloughs. In the *fourth* class the destructive effect reaches the subcutaneous areolor tissue, the sloughs are firmer and deeper, and, on separating, leave granulating ulcers. In the *fifth* class the deeper-seated structures, muscles, tendons, etc., are affected; while in the *sixth* class of burns, all the constituents of the part, including the bones, are involved in destruction. The various changes which take place in a part that is burnt, are those that have already been fully described in the chapter on Inflammation, and the processes of granulation, cicatrization, etc., by which repair is accomplished in these cases, are the same as in solutions of continuity from any other cause.

The *Constitutional Effects* of burns vary according to the *degree of the burn* and the *extent of surface involved*. In almost all cases, the constitutional symptoms may be divided into three stages, viz., that of depression, that of reaction, and that of exhaustion. The stage of depression is particularly well marked in cases of *extensive* burn, even though the *depth* of the injury be not very great. Many patients die in this stage, either from shock alone, or from this in combination with other causes, such as intense pain, or suppression of the physiological action of the skin. Thus, of ten patients received into the Pennsylvania Hospital from a fire at the Continental Theatre, in September, 1861, six died within twenty-four hours, some without any reaction, and others having reacted very imperfectly. The *second* stage is marked by the occurrence of inflammatory fever, accompanied often by violent traumatic delirium; the duration of this stage is usually from the second to the tenth or twelfth day, and during this period death may occur from internal congestion, or from inflammation of the brain, air-passages, or alimentary canal; the locality of the burn influences the seat of these secondary complications, a burn of the chest being followed by bronchitis or pneumonia, while one of the abdomen is more apt to cause inflammation of the bowels or peritoneum. A peculiar and very grave complication of this stage, which has been particularly insisted on by Long and Curling, is *perforating ulcer of the duodenum.* This, according to Curling, results from the irritation due to the vicarious action of Brunner's glands in attempting to replace the deficient action of the skin, but, according to Feltz and Wertheim, is, in common with the other visceral complications of burns, directly traceable to the occurrence of capillary embolism. The duodenal ulcer usually proves fatal either from hemorrhage, or by perforating the abdominal cavity, and thus giving rise to peritonitis. In the *third* stage of burn, the patient is in the condition of one suffering from profuse suppuration and wide-spread ulceration, without regard to the particular cause of the injury; death may occur from simple exhaustion, from secondary visceral degeneration (probably of the so-called amyloid or albuminoid variety), or from pyæmia. According to Ponfick and Lesser, one of the chief causes of death, in cases of severe burn, is disintegration of the red blood-curpuscles, with secondary parenchymatous inflammation of the kidneys, and uræmic poisoning.

Symptoms.—The *Local Symptoms* of burns are those of inflammation of the tissue affected, without regard to the cause. The intensity of the inflammatory process varies in different cases, and in different parts of the body in the same case, so that we generally find the first four, and sometimes all, of Dupuytren's degrees of burn in the same individual. The *Constitutional Symptoms* vary according to the stage, as well as the extent and severity of the burn. The most prominent symptom in the first stage is a *feeling of intense cold,* resulting, probably, in part, from direct injury to the cutaneous nerves, and, partly, from the accumulation of blood in the central organs of the body. The patient shivers, and complains of chilliness, the temperature of the surface is depressed, the features pinched, and the whole body in a state of partial collapse. With the development of the second stage, *thirst* becomes the most distressing symptom; there is an insatiable craving for liquids, which are rejected by vomiting as soon as they are swallowed. The patient is now very restless and feverish, and tosses off the bedclothes, which, during the first stage, could not be too closely applied. In the third stage, the symptoms are those of exhaustion and debility; the patient does not suffer much pain, except from the necessary exposure of dressing, unless the burns are so placed as to be subjected to pressure. Troublesome cough and profuse diarrhœa are often the most annoying complications in this stage of the injury.

Prognosis.—The prognosis, in any case of burn, depends chiefly upon the extent of surface involved: as a rule, it may be said that if one-half of the cutaneous surface be affected, no matter how slightly, the case will probably terminate fatally. Even if one-third, or one-fourth of the surface be burnt, the prognosis should be very guarded. Another point to be considered is the *locality* of the injury; a burn upon the trunk is more serious than one of similar extent upon the extremities. The depth of a burn is of less prognostic importance than its extent, at least as regards life, which may often be saved (when the lesion is in one of the extremities) by a timely amputation.

There is a popular idea that patients who are burnt often die from *inhaling flame;* it is, perhaps, scarcely necessary to say that such an occurrence is impossible; death, however, may occur from asphyxia (from the presence of smoke and noxious gases), or possibly from the flame entering the mouth, thus inducing rapid œdema of the glottis, and consequent suffocation. *Hot steam* may be inhaled (as is sometimes done by children from the spouts of tea-kettles), when death ensues from inflammation of the air-passages.

The older writers spoke of *critical days* in cases of burn, and the third and tenth days were especially so regarded. According to Mr. Holmes, however (and this corresponds with my own experience), most deaths from burn occur during the first forty-eight hours; of 194 fatal cases which were received into St. George's Hospital in sixteen years, 98 terminated during the first two days, 55 more during the first fortnight, and only 41 at a later period.

Treatment.—The *Constitutional Treatment* of burns is of the greatest importance. The first thing to be done is to promote reaction. The patient should be placed in bed and covered with blankets, while foot-warmers, or hot bricks or bottles, are employed to maintain an elevated temperature. Brandy and opium may be given pretty freely, care being taken, of course, not to intoxicate the patient; if he be already inebriated, reaction may be promoted by the use of other stimulants, such as carbonate of ammonium. As soon as reaction has begun, nutritive liquids, such as beef-tea or milk-punch, should be given, in small quantities and at frequent intervals, taking care not to excite vomiting by overloading the stomach. Thirst may be allayed by permitting the patient to suck small lumps of ice, or by the moderate use of carbonic-acid water; but the patient should not be allowed to deluge his stomach with liquids, as the consequent vomiting and attending depression would of themselves often suffice to insure a fatal result. Transfusion of blood is, on theoretical grounds, recommended by Ponfick.

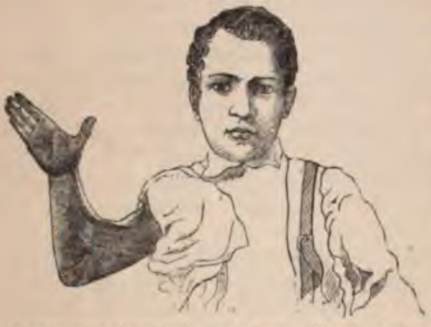
During the first week or ten days of a burn, the patient is often constipated, and requires mild laxatives or enemata; diarrhœa is apt to supervene at a later stage, and must be met with chalk-mixture, astringents, and opium. Retention of urine must always be watched for during the early stages of a burn, especially with female patients, who, from a feeling of modesty, frequently conceal their sufferings in this respect. When a patient has thoroughly reacted, the treatment consists chiefly in the administration of food and stimulus. Two or three pounds of beef, in the shape of beef-tea, with ten or twelve fluidounces of brandy, and a quart or two of milk, is no unreasonable daily allowance for a bad case of burn. The only drug habitually required is opium: twenty minims of laudanum, or half a grain of sulphate of morphia, every six hours, is often not too much to relieve pain and promote necessary sleep. Traumatic delirium, if it occur, is to be treated on the principles already laid down, and other complications are to be met as they arise. During the third stage, tonics are usually required, the best being iron, quinia, and the mineral acids. *Secondary amputation* may be required, either by the depth of the burn, or by the state of general exhaustion of the patient; if by the latter, the operation should not be too long postponed, on account of the risk, already referred to, of the occurrence of visceral degeneration, probably of the so-called amyloid or albuminoid variety.

With regard to *Local Applications* to burns, I do not believe that it makes a great deal of difference what article is used, provided that the surface is thoroughly excluded from the air, and that the process of dressing is neatly and properly attended to. The application which I myself prefer in cases of recent burn, is the old-fashioned *carron oil,* made by stirring linseed oil and lime-water into a thick paste, which is then spread upon old linen or muslin, and covered with oiled silk. It is customary to speak of this as a *filthy* dressing, but I cannot see that it is any less clean than other applications, while it is certainly, according to my experience, extremely soothing and agreeable to the patient. Other dressings may, however, be used, if the surgeon prefer, and excellent results are doubtless obtained with raw cotton, flour, white paint, lard, glycerine, iodoform, or any other of the host of substances which have been recommended.

More important than the particular article used is the mode of using it. Only a small portion of the surface should be uncovered at once, and the burn, if extensive, should thus be dressed, as it were, in detachments. Vesications, if there be any, should be punctured with the point of a sharp knife, the contained serum being allowed to drain away of itself, so as to preserve the cuticle as a covering for the parts beneath. The dressings should be covered with oiled silk or waxed paper, to prevent evaporation, and should be held in place with roller bandages, the injured parts being supported in an easy position, with soft pillows covered with oiled silk, or with pads of cotton wadding. The dressings should be entirely renewed, as a rule, once in two days; while unnecessary disturbance of the patient is to be deprecated, the discharge is usually so profuse and offensive, that to delay a change of the dressings longer than this does more harm than good. When the sloughs have separated, the remaining ulcers may be dressed with lime-water, dilute alcohol, or zinc or resin cerate, as in the case of any other granulating surface. While the dressing is to be conducted with all gentleness, it must be neat and thorough; especial care should be taken to wipe clean the newly-formed skin around the healing ulcer, which may be advantageously stimulated from time to time by light touches with lunar caustic or blue stone. During the healing process, care must be taken to guard against undue contraction of the cicatrix, by the use of appropriate splints and bandages. This contraction is particularly apt to occur at the flexures of the joints, and in the neck, where it draws the chin down to the sternum, or ties the head to the shoulder, producing the most frightful deformity, which may be irremediable except by operative interference.

Operations for Contracted Cicatrices.—In the early stages, before healing is completed, or afterwards if the cicatrix be still soft and pliable, it may be possible to prevent deformity by the use of splints and careful bandaging, or by means of elastic rings and bands, so applied as to counteract the contractile tendency. In dealing with old cicatrices, in which the contraction is firm and long established, severer measures are necessary. In the hand or foot, the deformity may be so great, and the cause of so much inconvenience, as to require amputation. In the neighborhood of the joints, as of the elbow, it may be sufficient to divide the cicatrix by a free incision carried into healthy tissue on both sides of, and beneath, the scar; the after-treatment consists in making extension by means of screw apparatus, or, which I think better, the ordinary weight extension, applied to the limb below the scar, with lateral support by means

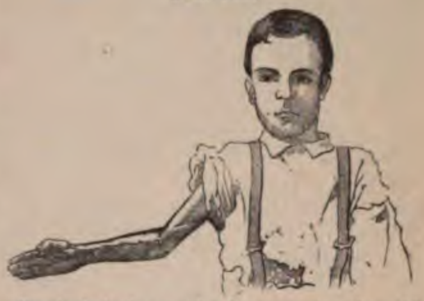
FIG. 159.



Contraction of arm following a burn. (From a patient in the Episcopal Hospital.)

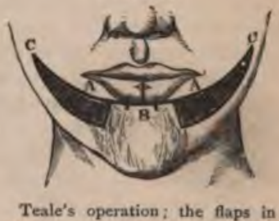
of side-splints or a fracture-box, the wound being allowed to heal while the limb is in the extended position. The result of such an operation is shown in Figs. 159, 160, from photographs of a patient under my care some years since in the Episcopal Hospital. These operations are not entirely free from risk, for important vessels and nerves sometimes adhere very closely to the cicatrix, and may be wounded in its division, or may themselves be shortened in the general contraction, when their integrity will be endangered by the process of extension. Simple division of the cicatrix is not sufficient in the case of burns about the face and neck, and here various plastic operations have been practised by Mütter, Buck, and others, to remedy the deformity, which is both annoying and painful. No general rules can be given for the management of these cases, which must be left to the ingenuity and skill of the surgeon in each particular instance. It may be said, however, that when the extent of the injury permits it, flaps of sound tissue should be brought, by twisting or by sliding, to cover the space left by free division and dissection of the cicatrix. In cases, on the other hand, in which this cannot be done, an attempt may be made to utilize the cicatricial tissue itself, as has been ingeniously and successfully done by Butcher, of Dublin. Mr. Butcher's operation, which has for its object the restoration of the elasticity of the cicatricial flap, consists in scoring subcutaneously the hardened tissue, with numerous incisions made with a long, narrow-bladed knife. The surgeon is thus enabled to unfold, as it were, the matted cicatrix, and render it available for autoplastic purposes. When the deformity is limited to dragging down and eversion of the *lower* lip, Teale's modification of Buchanan's cheiloplastic operation will be found very useful; this consists in dissecting up flaps from the sides of the lower lip (Fig. 161, A), and then joining these flaps together, and to the freshened edge of the central portion (B), which affords a firm basis for their support; the triangular spaces (C) which are left are allowed to heal by granulation. James, of Exeter, has supplemented the use of the knife, in these cases, by the employment of a screw-collar, which gradually pushes the chin away from the sternum. In the case of the *upper* lip, Teale makes a crucial incision of which the point of intersection is immediately below the septum of the nose. The incision involves the whole thickness of the part, and the operation is completed by dovetailing together the resulting lateral triangles, so as to increase the depth of the lip at the expense of its breadth. W. Adams has introduced an ingenious mode of treating small *depressed cicatrices*, by simply dividing subcutaneously the deep adhesions of the part, everting the scar, and maintaining it in the everted position by the use of hare-lip pins for three days. This mode of treatment is manifestly inapplicable to large scars, and is indeed particularly recommended by its author for the cicatrices resulting from glandular suppurations or from bone disease.

FIG. 160.



Result of plastic operation for contraction of arm following burn. (From the same patient as Fig. 159.)

FIG. 161.



Teale's operation; the flaps in place. (ERICHSEN.)

Anchylosis, or at least *Immobility of the Jaw*, occasionally occurs as a result of burns upon the cheek and side of the neck; under such circumstances, operations analogous to those of Barton and Sayre in the case of the hip-joint, have been proposed by Carnochan, Von Bruns, Rizzoli, and Esmarch. Rizzoli's operation consists in simply dividing the jaw with a narrow saw in front of the cicatrix, so that mastication may be accomplished by means of the natural articulation on one side, and the artificial false joint on the other. Esmarch meets the same indication by excising a wedge-shaped portion of bone, three-quarters of an inch wide at its upper part, and an inch below; but in a case thus operated on by Dr. Buck, of New York (for cicatricial contraction resulting from cancrum oris), though an inch and a half of bone was removed, the parts became re-approximated, and the operation seems to have been only partially successful: a better plan is, according to Durham, to separate the jaw with a screw-lever, and then endeavor to restore the functions of the part by practising passive motion. The statistics of Rizzoli's and Esmarch's operations have been investigated by Schulten, who finds that 26 cases of the former gave 13 permanent recoveries and 3 deaths, while 40 cases of the latter gave 15 permanent recoveries and 2 deaths.

The cicatrix of a burn sometimes assumes a peculiar warty appearance resembling *keloid*, this condition being more common in children than in adults. When the nature of the case permits, excision should be practised, but the cicatrix is sometimes too large to admit of this remedy; the itching may be relieved, according to Erichsen, by the internal administration of liquor potassæ. Occasionally a true cancerous formation appears to be developed in an old cicatrix, rendering excision (if practicable) still more imperative.

EFFECTS OF COLD.

The effects of cold are both constitutional and local. The *Constitutional Effects* of prolonged exposure to cold consist in the development of a state of drowsiness and indisposition to exertion, which, if not interfered with, will terminate in coma and death. Hunger, great fatigue, or any circumstance which impairs the general tone of the system, may increase the susceptibility to the effects of cold, and hence the liability of soldiers in a winter campaign to suffer from this cause. The *mechanism of death from cold* has been ably investigated by Lebastard, who finds that it may occur from several distinct conditions, viz., (1) in cases of sudden and progressive chilling, from cerebral anæmia; (2) in those of slow and continuous chilling, from cerebral congestion; (3) in those of sudden reheating, as pointed out by Mathieu and Urbain, from embolism due to clots formed by the disengagement of carbonic acid from the blood; and (4) in cases of partial congelation, usually from congestion, but sometimes from anæmia, in either case due to capillary embolism by clots originating in the injured part. Tourraine, Granjux, Pugibet, and other French military surgeons, have recorded curious cases of syncope preceded by intense redness of the whole surface of the body, as the result of cold baths. Hemiplegia was, according to Larrey, observed in many of the survivors of the retreat from Moscow. The treatment of a person *apparently dead* from cold, consists in placing him in a room of low temperature, and in practising systematic but gentle friction with snow, or with flannel wrung out of tincture of camphor or dilute alcohol, together with a resort to artificial respiration. These means should be continued until reaction is well established, when the body may be wrapped in blankets, stimulating draughts administered, and the temperature of the room gradually raised. Efforts at resuscitation in such cases should not be prematurely discontinued, as patients have occasionally been saved, even when apparently dead for several hours. Tédenat refers to a case in which a patient recovered after being buried in snow for 24 hours, and others in which persons were taken out alive after being similarly buried for four and eight days respectively. Nicolaysen reports a case in which recovery followed, although the temperature in the rectum had sunk to 76.4° Fahr.

The *Local Effects* of cold are divided, according to their intensity, into *Pernio* or *Chilblain*, and *Frost-bite*. Cold appears in some instances to cause the formation of a "perforating ulcer." (See Chap. XXVII.) Peripheral paralysis is occasionally traceable to exposure to cold, the nerves most commonly affected being the facial and radial.

Pernio or Chilblain is a very common affection, and is caused rather by sudden alternations of temperature, than by intensity of cold. It affects principally the extremities, especially the toes, heel, and instep, though it is also met with in the hands and face. The part affected is more or less deeply congested and swollen, and the seat of intense itching and burning. Vesication sometimes occurs, and may leave ulceration of an intractable character. A patient who has once had chilblains is very apt to suffer from a recurrence of the affection, upon even slight changes of the weather. The *treatment* consists in plunging the part into cold water or rubbing it with snow, following this application by the use of local stimulants, such as the nitrate of silver, tincture of iodine, or soap liniment. Fergus speaks very favorably of the employment of sulphurous acid. The remedy which I am in the habit of employing is the nitrate of silver in weak solution (gr. iv–v to f℥j), frequently painted upon the part, which is then wrapped in raw cotton. The nitrate of silver seems to obtund the local sensibility, and certainly relieves the burning and itching which in these cases are so distressing. The ulcerations which sometimes attend chilblain require stimulating applications, such as resin cerate, or dilute citrine ointment. T. Smith has called attention to the periodicity with which the paroxysms of itching in chilblain are developed, and which he is disposed to attribute to the time at which the patient's principal meal is taken. The daily paroxysm may be anticipated, if the patient's convenience so dictate, by immersing the part for a few minutes in a mustard bath.

Frost-bite results either from exposure to an intense degree of cold, or from prolonged exposure to a less degree. The parts most often affected are the nose, lips, ears, fingers, and toes, though occasionally the effect is more extensively diffused, whole limbs becoming frost-bitten. Fremmert, of St. Petersburg, found from an analysis of 494 cases, that in 333 the lower extremities alone were affected; in 105, the upper extremities only; in 38, both upper and lower extremities; in 12, the extremities and other parts of the body as well; and in only 6, other parts of the body without the extremities. The great toe and the little finger suffered much more frequently than any other parts, and the right side oftener than the left. Men were twelve times as often affected as women, and the most susceptible age appeared to be from 30 to 35. Of the whole number of cases, 42, or 8.5 per cent., terminated fatally, pyæmia and septicæmia being the most frequent causes of death. Operations to the number of 222 were performed upon 134 individuals, 15 of whom submitted to major amputations upon one or more limbs. The first effect of cold is the production of a dusky redness, with some tingling and pain; but further exposure causes a tallowy whiteness of the affected part, which is also shrunken, insensible, and motionless, presenting much the appearance of gangrene from arterial occlusion. Mortification may be induced directly by the intensity of the cold depriving the tissues of vitality, though more usually death of the part follows from the violent inflammation which results from undue reaction. Thus, Larrey found numerous cases of frost-bite caused by a sudden thaw, when the previous severe cold had given the affected person no inconvenience. The *treatment* of frost-bite consists in moderating the intensity of the reaction, and thus endeavoring to prevent the occurrence of mortification. For this purpose the affected part should be rubbed with snow or ice, or covered with wet cloths, which are kept cold by means of irrigation, the patient being meanwhile kept in a cold room. Bergmann recommends that the injured part should be suspended in an elevated position. By assiduously persevering in this mode of treatment, gradual reaction may be obtained, and the patient may escape with moderate inflammation, manifested by slight swelling and tingling, with perhaps some vesication, and desquamation of the cuticle. In this stage advantage may be derived from the use of stimulating washes, such as the tincture of iodine, or soap liniment. Even if mortification occur, the use of cold applications should be continued, as long as the gangrene manifests any tendency to spread. The occurrence of mortification is manifested by the part becoming black, dry, and shrivelled, a line of demarcation and separation forming as in gangrene from any other cause. If the mortified parts be of small extent, their removal should be left to nature, the process of separation being simply hastened by the use of fermenting poultices; the reason for this is that the vitality of all the neighboring tissues is impaired, and that the use of the knife might therefore be followed by a recurrence of gangrene. When the mortification has extended further, involving the greater portion, or the whole, of a foot or hand, a formal amputation will probably be ultimately required; even in such a case, however, it may be better, at first, simply to remove the gangrenous mass by cutting through the dead tissue below the line of separation, waiting to improve the shape of the stump by a regular amputation at a subsequent period, when the patient's general condition has been improved by appropriate constitutional treatment.

CHAPTER XV.

INJURIES OF THE HEAD.

INJURIES OF THE SCALP.

Contusions of the Scalp are chiefly of interest in a diagnostic point of view, the sensation which they communicate to the fingers of the surgeon being often deceptive, and leading to the supposition that the case is one of fractured skull. There is in both affections a rim of indurated tissue with a central soft depression, but in a contusion, firm pressure will usually detect the bone at the bottom of the cavity. The most skilful surgeons may, however, be deceived by these cases, and incisions have been made with a view of elevating depressed bone, the operation showing that no fracture existed. Large *collections of blood*, either coagulated or fluid, may result from contusions of the scalp, remaining apparently without change for a considerable period. As a rule, no incision should be made in these cases, but the surgeon should encourage absorption by the use of evaporating lotions, or of moderate pressure. If, however, suppuration occur, the pus must be evacuated by a free incision.

Cephalhæmatoma, or *Caput Succedaneum*, is a bloody tumor of the scalp in new-born children, resulting from pressure during birth. The blood is usually effused between the scalp and pericranium, though more rarely beneath the latter. The treatment is the same as for similar extravasations resulting from other causes.

Wounds of the Scalp.—Scalp Wounds do not differ materially from similar injuries in other parts of the body, as regards their pathology and treatment. The tissues of the scalp are extremely vascular,[1] hence the hemorrhage in these cases is often profuse; on the other hand, the vascularity of the scalp is of advantage, in enabling the parts to preserve their vitality after injuries which, in other tissues, would be certainly followed by extensive sloughing. In all ordinary wounds of the scalp, whether incised or lacerated, the detached flaps should be carefully replaced (the parts being cleanly shaved), and held in position with strips of isinglass plaster, or, which is better, with the gauze and collodion dressing, or one of its modifications (see page 147). A firm and broad compress should then be placed over the seat of injury, and secured by a suitable bandage; bleeding is thus readily checked, and the flaps are held in such a position as to favor union. I do not advise the use of either sutures or ligatures, in ordinary cases of scalp wound, simply because I do not believe them to be necessary. They are, indeed, thought by many surgeons to act as exciting causes of erysipelas, when applied to the scalp; but there is no proof, as far as I am aware, that they exert any such influence. They are, however, usually unnecessary, and therefore, of course, undesirable.

If a wound of the scalp be accompanied with so much contusion and laceration that sloughing appears unavoidable, it will be proper simply to support the flaps with adhesive strips, and apply to the wound some warm and soothing application, such as olive oil or diluted alcohol.

As in every case of scalp wound there is at least a possibility of some concomitant injury to the brain, a patient with such an injury should be carefully watched during the entire course of treatment; the diet should be regulated (all irritating or indigestible substances being avoided, while at the same time easily assimilable nutriment is provided in sufficient quantities), and attention should be given to the condition of the various secretions and excretions of the body.

Erysipelas and *Diffuse Inflammation of the Subcutaneous Areolar Tissue* are usually said to be especially apt to follow upon wounds of the scalp. Such has not been my own experience, though I can readily understand that a patient should be predisposed to these affections, when treated by the plan of excessive depletion formerly in vogue in the management of these cases. The proper course to be pursued in the event of such complications arising, would be to remove all pressure or sources of tension, by reopening the lips of the wound, and making counter-incisions, if necessary, for the evacuation of pus or sloughs.

Necrosis of the outer table of the skull usually, though not necessarily, follows in cases of scalp wound in which the bone is denuded of pericranium. Such a case should be treated upon ordinary principles, the sequestrum being removed as soon as it has become loose.

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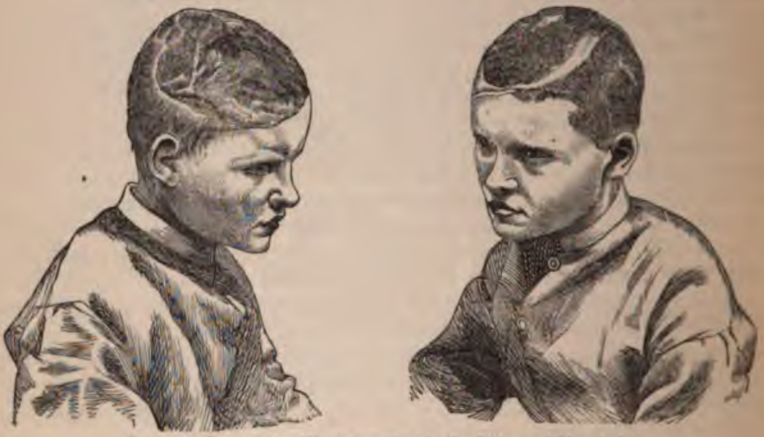
[1] W. J. Tyson has recorded a remarkable case of traumatic aneurism of the scalp (*Trans. Clin. Society*, vol. xiii.).

The accompanying cuts (Figs. 162, 163) illustrate the severest case of scalp wound which I have ever seen followed by recovery. The patient was a girl of fifteen, an operative in a cotton-mill, who was caught by her hair between rollers which were revolving in opposite directions, her scalp being thus, as it were, *squeezed* off from her head and forming a large horseshoe-shaped flap. The linear extent of the wound was fourteen inches, the distance between its two extremities being but four inches. This large flap was thrown backwards, like the lid of a box, the skull being denuded of its pericranium for a space of two and a half inches by one inch in extent. The anterior temporal artery was divided, and bled profusely, and the patient, when admitted to hospital, was extremely depressed by shock and hemorrhage. A ligature was applied to the bleeding vessel, and the flap, after it had been gently but carefully cleansed, replaced and held in position with the gauze and collodion dressing. A large compress soaked in warm olive oil was then placed over the entire scalp, covered with oiled silk, and fixed with a recurrent bandage. A considerable portion of the wound healed by adhesion, and the patient was discharged cured after fifty-four days. No exfoliation of bone occurred.

FIG. 162. FIG. 163.



Severe scalp wound. (From a patient in the Episcopal Hospital.)

CEREBRAL COMPLICATIONS OF HEAD INJURIES.

The principal risk attending all injuries of the head is from simultaneous or subsequent implication of the brain, and I shall, therefore, before speaking of fractures and other lesions of the skull, consider the various cerebral complications which are met with in these injuries, and which may be classified, as a matter of convenience, under the heads of *concussion*, *compression*, and *inflammation*.

Concussion of the Brain.—It is a rather mortifying confession, that the ideas of surgeons of the present day, as to this condition, are much less definite than those of their predecessors. We have, however, advanced so far, that we are now enabled to say pretty clearly what concussion is not, and thus to separate it from other conditions with which it was, formerly, habitually confused. Thus, we now know that *cerebral concussion* is not *shock* (see page 134), and that it is not a purely *functional*, apart from an *organic*, condition. The older writers had no hesitation in declaring that a man might die from concussion of the brain, without the existence of any physical lesion whatever, but the fallacy of this opinion has been ably exposed by modern authors, among whom should be specially mentioned Prescott Hewett, the well-known surgeon of St. George's Hospital. In fact, while there is no evidence that cerebral concussion is ever a cause of *instant* death, there are invariably found after death from this cause signs of *contusion, compression, extravasation, laceration*, or *inflammation*.

Concussion of the brain, as its name implies, consists in a *shaking* or, to use a Johnsonian word, a *tremefaction* of the cerebral mass, and it is easy to understand that such a trembling might be attended by a more or less temporary arrest of cell-action, by capillary stasis,[1] and by functional inactivity, without any persisting lesion, or permanent ill result. Such, indeed, is probably the condition of affairs in the slight cases of concussion or stunning which are not unfrequently met with, especially among children; though, these cases not proving fatal, our knowledge of their morbid anatomy must, of course, be purely conjectural.

A more violent concussion of the brain may cause contusion or laceration of the cerebral structure itself, or rupture of the cerebral vessels, giving rise to extravasation with or without compression, and more remotely followed by inflammation, suppuration, or softening.

Contusion and Laceration of the brain, like the same conditions in other organs, may vary from the slightest bruising or separation of fibres, to the most extensive crushing and tearing, sometimes amounting to complete pulpefaction and disorganization of the whole cerebral mass. The symptoms and prognosis of these injuries depend upon their extent, and upon the particular part of the brain which is affected; thus, Mr. Callender has shown that *pain* is especially connected with lesions of the outer gray matter of the brain, and *convulsions* with lesions in the neighborhood of the middle cerebral arteries, and particularly in that portion of the right hemisphere which is above the corpus striatum. A laceration involving the medulla oblongata would, of course, be more apt to prove fatal than one of similar extent in a less vital part.[2]

The *extravasation* which invariably accompanies cerebral contusion, presents various appearances in different cases; thus there may be numerous points or specks of extravasation, each not larger than a millet-seed (*miliary extravasation*), or the blood may be poured out in larger masses, forming collections the size of a split pea. The latter form of extravasation is easily recognized, but the former may be mistaken for the appearance presented by the cut surface of the cerebral vessels—from which, however, it may be distinguished by the fact that the points of extravasation are not easily wiped away, and, if picked out, leave behind them small but distinct cavities. The occurrence of these miliary extravasations is accounted for by Duret by the diffusion of the force of the injury by means of the cerebro-spinal fluid.

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[1] According to Fischer, of Breslau, the phenomena of concussion are due to reflex paralysis of the intracranial vessels, but, from experiments on the lower animals, Duret concludes that they depend on increased tension of the cerebro-spinal fluid—a conclusion, however, which is strenuously rejected by Bochefontaine.

[2] According to Brown-Séquard, lacerations of the brain are followed by pleural ecchymosis or pulmonary apoplexy on the side opposite to that of the cerebral lesion. Fleischman and Ollivier have observed a similar condition of affairs in cases of non-traumatic disease of the brain. Extravasation has also been noted, in connection with brain lesions, in the heart, kidneys, and other organs. On the other hand, cerebral abscess appears sometimes to result from embolism following pulmonary disease, as in cases recorded by Gull and Sutton, Huguenin, and J. H. Hutchinson, of this city, or from congenital communication between the right and left cavities of the heart, as in cases recorded by Ballet, Gintrac, and others.

Contusion of the brain, with its attendant extravasation, may be *circumscribed* or *diffused;* the former condition is frequent, and the latter rare. Certain parts of the brain are more exposed to contusion than others; thus the base of the brain is more often affected than the upper part; the middle and anterior, than the posterior lobes; the cerebellum, than the pons and medulla. The reason for this difference is, doubtless, as pointed out by Brodie, the greater or less irregularity of the surface of the various portions of the skull.

When extravasation takes place on the surface of the brain, or into its ventricles, or even (in large amount) into its substance, the characteristic symptoms of *compression* are developed—a condition which will be presently considered.

Causes of Cerebral Concussion.—Concussion of the brain may be caused by various forms of external violence, such as a direct blow or fall, by violence resulting from counter-stroke, as a fall on the loins, buttocks, or feet, or even by sudden and violent agitation of the surrounding air, as by an explosion in a patient's immediate vicinity.

Symptoms of Cerebral Concussion.—Every case of concussion is, I believe, accompanied with *shock*, and in many instances the symptoms of the latter condition alone can be recognized. The patient, after a blow on the head, becomes pale and somewhat collapsed, with a cool surface, small and feeble pulse, diminished power of sensation and motion, and partial unconsciousness; after a variable period these symptoms pass off, vomiting may or may not occur, and the patient is apparently quite as well as before the accident. The symptoms here are evidently those of shock (with the exception of unconsciousness), and cannot be considered as in any degree characteristic of the brain lesion. So again, in cases in which death follows in a few minutes or hours after an injury to the head, the patient lying meanwhile senseless and collapsed, the fatal result may be due to shock, or to intra-cranial hemorrhage, or to laceration of a vital part of the brain; but there is no symptom which we can point out as pathognomonic of concussion, apart from other conditions. Even in the intermediate cases, which are often spoken of as typical instances of concussion, though, as a matter of convenience, we may trace their clinical history, and divide it into stages, we cannot point to any symptoms which definitely characterize the lesions of concussion, apart from those of other cerebral injuries. Indeed, it would be better, I think, if we could dispense altogether with the term concussion as denoting a *condition*, and look upon it as merely indicating the *cause* of what have been described as *concussion lesions*, viz., *cerebral contusion*, *laceration*, *extravasation*, etc. With this explanation and reservation, the clinical history of a typical case of so-called concussion of the brain may be said to present *three stages*, the symptoms of which are as follows:

In the *first stage* the patient lies motionless, senseless, nearly pulseless, pale and cold, breathing feebly but naturally, the pupils dilated or contracted, fixed or acting freely (according to the particular seat and form of lesion),[1] with perhaps involuntary discharge of feces and urine. From this first stage the patient may recover without any further trouble, or he may gradually sink and die without reaction; or the first stage may be very evanescent, so that when the surgeon first sees the patient he has already passed into the *second stage*, which Mr. Erichsen regards as an entirely independent condition, and graphically describes under the name of *Cerebral Irritation*. The disappearance of the first stage, whether by passing into the second or by direct recovery, is commonly marked by the occurrence of vomiting. In the *second stage* the patient is no longer unconscious, though much indisposed to speak or pay attention to surrounding objects. If roused by a question, he will answer, but peevishly or angrily, turning away as if displeased at the interruption. The posture of the patient is peculiar; he habitually lies on one or other side, curled up, with all his joints more or less flexed, and if a limb be touched, draws it away with an air of annoyance. The eyelids are kept firmly closed. The pulse during this stage, at first small and weak, becomes gradually fuller and more frequent, while the breathing is easier, and the surface regains its natural warmth and color. The symptoms now may be masked by those of the second stage of shock (see page 136), and thus, instead of being morose and taciturn, the patient, though still irritable, may be voluble and loquacious. The condition of cerebral irritation which marks the second stage of concussion, gradually subsides, after having lasted several hours or days, the patient almost invariably complaining of severe headache as he regains ability and willingness to communicate with those around him. The *third stage* varies in different cases: in some, there is positive inflammation of the brain and its membranes; in others, as irritability subsides, fatuity takes its place, and a state of weakmindedness supervenes, which may end in recovery, or in cerebral softening and death.

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[1] Cerebral compression appears to be marked by fixed or slowly moving pupils; mere laceration does not affect their free action. (See Mr. Callender's paper in *St. Bartholomew's Hosp. Reports*, vol. v., p. 25.)

Prognosis.—From what has been said, it is evident that the prognosis in any case of cerebral concussion or contusion should be very guarded; the patient may die, as we have seen, in the first stage, from the shock of the injury; or, if he escape this risk, from intra-cranial congestion or inflammation; or, at a still later period, from softening of the brain or cerebral abscess. As a rule, however, if the first stage be slight, we may expect the others to be so likewise, and, numerically, the proportion of deaths to the number of cases of slight concussion, or stunning, is very small; still, it is not always possible to be sure that the amount of brain lesion is as slight as it at first appears, and every case of concussion must be, therefore, a subject of grave interest to the surgeon.

Treatment of Cerebral Concussion and Contusion.—There is a popular notion that a person who has received a stunning blow on the head should not be allowed to sleep, or even to lie quietly in bed: need I say that this is as unreasonable as it is cruel? The first indication for treatment is certainly to place the injured organ at rest, and it would be no more unphilosophical to insist that a man should walk with a contused foot, or write with a lacerated hand, than to expect him to exert the mental faculties when suffering from concussion of the brain. A patient thus affected should be placed at rest, in bed, in a cool and moderately darkened room, and should be disturbed as little as possible. If the state of shock be so great as to threaten death from asthenia, the patient must be stimulated, preferably, however, as far as possible, by external applications, such as sinapisms or hot bottles, and by those internal remedies which are most evanescent in their effect, such as the spirit of hartshorn or carbonate of ammonium. As a matter of fact, it is very seldom indeed that a case of concussion requires any stimulus at all. Reaction usually begins in the course of an hour, or two or three hours, sometimes much earlier, and as the pulse rises, the stimulants, if any have been given, must be discontinued. The risk now is from congestion or extravasation, with subsequent inflammation, and the treatment must be directed accordingly. It is in this stage that cold, and especially dry cold, is particularly useful as a local application. In the first stage it would have added to the existing depression, but it is now eminently indicated, and is a most valuable remedy. Esmarch's ice-bag or Petitgand's apparatus may be employed, or, in the absence of these, cloths wrung out of cold water should be assiduously applied. The secretions and excretions should be regulated, the bowels being opened with enemata, or occasional mercurial or saline purges, and the bladder relieved by catheterization if necessary. The diet should be very light, and administered in small quantities at a time; there is no article of food better, under these circumstances, than milk, to which lime-water should be added if there be vomiting. Rest, both mechanical and physiological, should still be enforced; and if the patient be restless, the surgeon need not fear to give opium. I am aware that there is a good deal of difference of opinion as to the propriety of administering opium in injuries of the head, but surely there is nothing to contraindicate it in what we know of the pathology of these cases, while its soothing and calming effect is exactly what is required. Metaphorically speaking, it puts the brain in splints, and thus places it in the most favorable position for the repair of its injuries. Of course, opium in these, as in all other cases, should be used with discretion, and if there be any threatening of coma, should not be given; but in such a case the restlessness which calls for it would not be present.

By perseverance in this plan, the patient will, in most cases, be tided over the second stage, and may then be allowed gradually, and with great caution, to resume his usual mode of life. For a long time, however, he should live by rule, guarding against all sources of irritation, eating and drinking very moderately, and in fact remaining, if not under treatment, at least under surgical supervision. If, on the other hand, the case progresses less favorably, and the contused and lacerated brain becomes inflamed, the chances of recovery are much diminished; *traumatic encephalitis* is, however, of such importance as to demand separate consideration.

Compression of the Brain.—It is not my purpose to enter into a theoretical discussion as to whether the brain is susceptible of being actually compressed, or whether, in the condition known as compression, it merely changes its form, expanding at other parts to compensate for its apparent contraction at the seat of lesion. The term cerebral compression is so universally employed by surgeons, and is in many respects so convenient, that I shall not hesitate to use it, although it may not exactly describe the condition which it is meant to represent.

Causes.—Compression of the brain may be caused by various circumstances: thus, it may be due to the pressure produced by a foreign body, as a bullet or piece of shell; by a portion of displaced bone; by effusion of blood, either on the surface of the encephalon or within its mass; or by what are ordinarily called the products of inflammation—lymph, serum, and pus.

Symptoms.—The symptoms of compression are as follows: The patient lies unconscious and comatose; the breathing is slow, and accompanied by stertor, and by a peculiar blowing motion or whiff at the corners of the mouth; this sign, which is very striking, appears to be due to paralysis of the cheeks, and is compared by the French writers to the act of a man smoking a pipe. The pulse is full and rather slow, the decubitus dorsal, and the skin usually cool, though sometimes hot and moist. There is retention of urine, and the feces are passed unconsciously. The pupils are fixed and immovable, usually midway between contraction and dilatation, sometimes widely dilated, and rarely contracted; or one pupil may be contracted, while the other is dilated; the difference in different cases depending, as shown by Callender, upon the part of the brain involved. There is paralysis of motion, usually affecting the side opposite to the seat of injury. The period at which the symptoms of compression are developed, depends on the particular source of the pressure: if this result from depressed bone or a bullet, the symptoms will be instantly manifested, and the patient will probably continue in a completely comatose condition, from the moment of injury, either till the pressure is removed, or till the case ends in death; this, it will be remembered, was the course of events in the case of President Lincoln. If, however, compression be caused by extravasation, it will begin gradually, and slowly increase during several hours, until the intra-cranial bleeding has spontaneously ceased, or has been artificially arrested; while compression from lymph, serum, or pus comes on at a still later period of the case.

Diagnosis.—I regret that I cannot agree with those surgeons who consider the diagnostic marks between compression and concussion to be plain and easily recognizable. Unfortunately, as our knowledge of the pathology of concussion has increased, the several symptoms[1] which we formerly regarded as pathognomonic, are shown to be often common to both conditions; and this is not surprising when we remember that extravasation is an almost constant lesion of *concussion*, and a frequent cause of *compression*, thus rendering the difference between the two conditions, in many cases, one of degree only. It used to be said that the symptoms of concussion were immediate and temporary; those of compression, often not immediate, but permanent. We have, however, seen that the first stage of concussion presents no definite symptoms; none, in fact, which might not be due to shock and syncope (conditions which might equally complicate compression)—while, if concussion be attended with much extravasation, compression itself may result. Again, if compression be caused by a foreign body, or by displaced bone, the symptoms will be immediate—while in many cases of slight compression, the brain in a short time becomes habituated to the source of pressure, when the symptoms may pass off without surgical interference. And so with the other symptoms which used to be considered diagnostic, there is not one, I believe, which can be implicitly relied upon. A man was brought into the Episcopal Hospital with a compound, comminuted, and depressed fracture of the frontal bone, with rupture of the membranes, and escape of brain substance. When I saw him he was comatose, and evidently suffering from compression of the brain; I removed those fragments of bone that were loose, and elevated the remainder; the patient breathed somewhat less stertorously, and turned on his side; the next day he was conscious, and rapidly recovered. Here there was manifestly compression from an obvious cause—depressed bone; and yet the only change in symptoms produced by relieving this compression (the accompanying concussion remaining), was a diminution in stertor, and the substitution of lateral for dorsal decubitus. Hence, though in certain cases we can say without hesitation, in view of the one-sided paralysis, profound coma, and other symptoms mentioned, this is compression or that is concussion, there are other cases in which it is impossible to draw such a distinction; compression may disappear spontaneously, leaving concussion, while concussion, by a continuance of intra-cranial hemorrhage, may end in fatal compression.

Prognosis.—Compression *in itself* is not a very fatal condition; in many cases, in which the pressure is not very great, the brain accustoms itself to the new state of affairs, and the patient regains consciousness, and goes on to recovery. In other cases it is possible by surgical interference to relieve the compression, and then, if the brain itself be not structurally altered, there is a good prospect of recovery. The gravest forms of compression are those which result from intra-cranial hemorrhage or suppuration, the latter condition being particularly dangerous, and proving almost always, sooner or later, fatal. Duret has shown experimentally that as soon as the compression becomes so excessive as to surpass the arterial tension, death supervenes.

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[1] Bouchut has recently asserted his ability to distinguish concussion from compression of the brain by the use of the ophthalmoscope, the optic nerve and retina presenting a normal appearance in the former condition, and evidences of intra-cranial pressure ("choked disk") in the latter; but it is evident that if the views advanced in these pages as to the pathology of "concussion" be correct, this test could only serve to distinguish those slight cases in respect to which no confusion would be likely to exist.

Treatment of Cerebral Compression.—When the cause of compression is recognizable, an attempt should obviously be made to remove it. Thus, if compression be due to a fragment of bone, this should be elevated or removed, provided that it can be done with safety; or if to hemorrhage, in a situation which can be reached, the surgeon may make an effort to evacuate the effused blood and secure the vessel; if, however, the cause of the compression be uncertain, and still more if the existence of compression itself be doubtful, it will, I think, be usually wiser to abstain from operative interference, and to treat the case on the general principles which have been laid down, in speaking of the management of the second stage of cerebral contusion (page 315). Purgatives may be employed in these cases pretty freely; and, if the patient cannot swallow, a drop of croton oil in mucilage may be placed on the tongue, while the bowels are solicited by turpentine enemata. The question of *trephining* in these cases will be considered hereafter.

Traumatic Encephalitis, or inflammation of the cranial contents as the result of injury, is a very serious complication, both of fractured skull, and of the severer forms of cerebral concussion and contusion. The brain substance itself may be affected, or the meninges, or both together; the arachnoid membrane is perhaps more commonly involved than any other part of the cranial contents. The meninges are injected with blood, while yellowish, or greenish, and sometimes puriform, lymph occupies the cavity of the arachnoid and the meshes of the pia mater, the arachnoid itself becoming thickened, and assuming an opalescent appearance. According to Hewett, in cases of meningitis originating from injuries of the *skull*, lymph will be chiefly found on the dura mater and in the cavity of the arachnoid; while in those cases which originate from injury of the *brain* (as after concussion), the pia mater is chiefly affected, the arachnoid cavity often escaping. Inflammation of the brain substance itself, chiefly affects the gray matter and superficial white substance, and is marked by great congestion, a dusky leaden hue, and softening, which comparatively seldom affects the central white parts, such as the fornix. Traumatic encephalitis may end in *suppuration*, cerebral abscesses not unfrequently following upon seemingly slight injuries, and occurring after long intervals of apparent health.

Symptoms of Traumatic Intra-cranial Inflammation.—These are pain (especially referred to the seat of injury), heat of head, fever, contraction of pupils, photophobia, and intolerance of sound; at a later period there are added vomiting, jactitation, delirium, convulsions, stupor, subsultus, paralysis, and coma. The occurrence of suppuration is frequently marked by repeated rigors.

The period at which encephalitis is devoloped varies in different cases; thus, after general and wide-spread concussion, inflammation may come on in a few hours; after limited laceration, probably not for several days—while inflammation resulting from contusion or fracture of the skull may occur at a still later period.

No very trustworthy information as to the precise seat of inflammation can be derived from the symptoms. The researches of Callender would seem to show that pain is especially connected with lesion of the gray matter, and convulsions with disease about the track or distribution of the great vessels, especially the middle cerebral arteries. Solly, however, looks upon convulsions as characteristic of inflammation of the tubular portion of the hemispheres, and Dr. Watson, of the pia mater or arachnoid; while Brodie and Hewett have seen convulsions follow injuries of the head when there was no evidence of any inflammation at all. Death may result from pressure of lymph or pus on the surface of the brain (in cases of arachnitis), from softening of the brain tissue, from the occurrence of intra-cranial hemorrhage, or from an abscess bursting into the ventricles; or it may result secondarily from thrombosis and pyæmia.

Intra-cranial Suppuration may occur between the skull and dura mater (*subcranial*), in the cavity of the arachnoid and the meshes of the pia mater (*inter-meningeal*), and in the substance of the brain itself (*intra-cerebral*). Subcranial suppuration results from lesion of the bone, and is only met with at the seat of injury; the other varieties may also result from counterstroke, and may therefore be found at a distance from the point at which the violence was applied. The first and third forms of intra-cranial suppuration are circumscribed, the latter constituting the ordinary cerebral abscess, which may last for an indefinite time without producing any marked symptoms. Inter-meningeal suppuration is commonly widely diffused, occupying the region of the vertex, usually on the side of the external injury, but occasionally opposite to it.

The *symptoms* of intra-cranial suppuration are those of cerebral irritation and compression; but I do not know of any signs which will enable the surgeon positively to distinguish the presence of suppuration from that of arachnitis.

The *prognosis* in all these cases is very unfavorable; pus has, however, been occasionally evacuated from beneath the cranium, the patient recovering; and incisions have been made through the dura mater, and even into the brain substance, in search of pus. Operations of this kind have been recorded by La Peyronie, Dupuytren, Guthrie, Dunville, Detmold, Noyes, Clark, Weeds, Holden, Maunder, Tillaux, Hulke, Chinault, Lloyd, Courvoisier, Morehouse, Bontecou, Stimson, Peck, Jalland, Elcan, and myself, and 13 of the 22 cases are said to have terminated successfully.

Treatment of Traumatic Encephalitis.—Intra-cranial inflammation is to be treated on the general principles laid down in Chapter II. *Bleeding* was formerly considered absolutely necessary in these cases, and is still resorted to by some surgeons. I have already expressed my views so fully as to the employment of venesection in the management of inflammation, that I shall not revert to the subject here, further than to say that I have never had occasion to bleed for encephalitis, though I have with advantage drawn blood, locally, by cupping. *Purging* is doubtless a most valuable means of treatment in these cases, but should be employed with due caution, and not pushed so far as unnecessarily to weaken the patient. Desault derived advantage from the use of large doses of *tartar emetic*, but the remedy is a dangerous one, and is now seldom employed. *Calomel and opium* are, I think, of great service in the treatment of these cases, and may be given in doses of a quarter of a grain of the former, with a sixth of a grain of the latter, every three hours, till the gums are slightly touched, when the mercurial should be suspended, and *iodide of potassium* may be substituted. *Cold to the head* is a valuable remedy, and is very grateful to the patient, as relieving the headache, which is one of the most painful symptoms of intra-cranial inflammation. In the latter stages, a *blister* to the nape of the neck, or even to the entire scalp, is recommended by some authorities. The diet should consist of fluids, and should be light and unirritating; if the general condition of the patient require it, however, the surgeon must not hesitate to administer concentrated nutriment, or even stimulus.

After injuries of the head, the brain often appears to be left in an irritable condition, the patient suffering from headache, vertigo, insomnia, etc. Under these circumstances, I have derived benefit from the use of the bichloride of mercury (in very small doses), or of the bromide of potassium, which may be given freely, and seems to act well as a hypnotic. The state of the bowels should always be looked to, in these cases, care being taken to avoid constipation. The question of *trephining*, for intra-cranial suppuration, will be discussed in its proper place.

INJURIES OF THE SKULL.

Contusion.—Contusion of the skull, without fracture, is a very serious injury, being commonly accompanied with grave lesions of the brain; the part of the skull which is bruised may become necrosed, and eventually exfoliate; or, from separation of the dura mater, subcranial suppuration may occur and prove fatal. These injuries are chiefly met with as the result of gunshot wounds, though occasionally resulting likewise from the accidents of civil life. The *trèatment* consists in combating cerebral irritation, by the means already described, and in removing sequestra, in case of exfoliation. If a patient with contused skull become comatose, it is usually recommended to apply a trephine, with the hope of being able to evacuate pus from beneath the skull; the facts already referred to, viz., that it is impossible to distinguish intra-cranial suppuration from arachnitis, and that, even if the existence of pus were certain, its locality could not be determined, are, however, sufficient to show how slight would be the prospect of benefit from such an operation. Thus, in a case of gunshot contusion of the *left* parietal bone, which proved fatal at Cuyler Hospital, there were found after death arachnitis of the *right* side, and abscess of the *left* hemisphere of the brain, at a point corresponding to the seat of injury—showing that trephining on either side would have been utterly useless. The operation was, according to Dr. Otis, resorted to in twelve cases of gunshot contusion of the skull, during the late war, but in every instance unsuccessfully.

Fracture of the Skull.—Fractures of the skull may be simple or compound, comminuted, etc. They may be conveniently classified as fractures without displacement (*fissured fractures*), and fractures with displacement (*depressed fractures*), the latter class being again subdivided into *impacted* and *non-impacted* depressed fractures.[1] In some rare cases, the fracture may be limited to the outer table, which is depressed upon the inner; in other instances, the inner or vitreous table is alone broken, the outer escaping. As a rule, the inner table is more extensively shattered than the outer, the exception being when the force is applied from within, as in the discharge of a pistol into the mouth. The cause of this difference is to be found, as pointed out by Teevan, in the well-known fact in mechanics, that fracture begins uniformly in the line of *extension*, and spreads further in this than in the line of *compression*, and that (in the case of gunshot fracture) the bulk of the fracturing body is absolutely augmented in its passage through the bone.

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[1] Other subdivisions are sometimes made, such as the *starred fracture*, and the *camerated fracture* (a form of the *depressed* variety).

Any part of the skull may be broken by either direct or indirect violence, the parietal and frontal bones being most often affected in fractures of the vault, and the temporal and sphenoid bones in those of the base of the skull. *Fracture of the base of the skull* is the most fatal form of simple fracture, usually resulting from *indirect violence*, such as a blow on the top or side of the head, or a fall from a height on the feet or hips; it is generally, if not (as believed by Aran and Hewett) universally, complicated by one or more fissures extending upwards into the vault. *Depressed fracture* of the skull is very rarely met with except in the vault, and results from *direct violence*. C. B. Ball, an Irish surgeon, has, however, collected several cases in which the base of the skull was driven in, and the condyle of the jaw impacted in the opening, by force transmitted through the lower maxilla.

Symptoms of Fractured Skull.—A Simple Fissured Fracture of the vault of the skull presents no symptoms which can be considered diagnostic. If there be an external wound, the line of fracture can be usually recognized, though a mistake has arisen, even under these circumstances, from an abnormal position of one of the cranial sutures.

Fracture with Displacement, if compound, is readily recognized; but, if unaccompanied by an external wound, may, as already mentioned, be confounded with a simple scalp contusion (p. 310). In some rare instances the displacement is outwards, but much more commonly inwards, constituting the ordinary *depressed* fracture of the skull. The displacement in the *impacted* fracture is slight, the depression being less than the thickness of the skull; in the *non-impacted* variety it is usually much greater, fragments being often deeply imbedded in the substance of the brain itself.

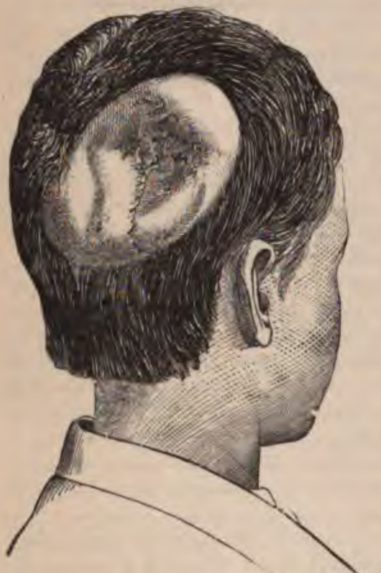
Fracture of the Base of the Skull may be suspected in any obscure case of injury to the head, which presents marked brain symptoms; and there are two signs in particular, which, though they cannot perhaps be considered pathognomonic, are unquestionably very significant, and render the existence of fracture at least extremely probable. These signs are the occurrence of *intra-orbital ecchymosis* and of *bloody and watery discharges from the ear.*

1. Fracture, involving the anterior fossa of the base of the skull, may cause *hemorrhage from the nose*, or *into the deep parts of the orbit.* The blood may flow backwards through the posterior nares into the mouth, and, being swallowed, may subsequently cause hæmatemesis, giving rise to a suspicion that some lesion of the abdominal viscera may have occurred. Hemorrhage into the orbit and areolar tissue of the eyelids, constituting in the former position what is known as *Intra-orbital Ecchymosis*, is commonly considered as presumptive evidence of the existence of fracture of the anterior fossa, though this symptom may, of course, be due to the giving way of a blood-vessel, without lesion of the bony structures, and may even, as pointed out by Lucas, result from a superficial injury, the blood passing backwards from the eyelids to the subconjunctival ocular tissues. This form of ecchymosis may, however, be distinguished from the subconjunctival and subcutaneous palpebral ecchymosis which constitutes the ordinary "black eye," by the fact that it is unaccompanied by contusion of the superficial structures, and that it is not a primary phenomenon; it is, indeed, caused by the gradual leakage of blood from within (the subconjunctival tissue being involved *before* the eyelids), and frequently does not reach its point of greatest intensity until several days after the time of injury. The hemorrhage is usually venous, probably resulting from laceration of the cavernous sinus, though it may be arterial, going on to the formation of a circumscribed traumatic aneurism, and eventually requiring ligation of the carotid artery—an operation which has been successfully resorted to under such circumstances by Busk, Scott, and others.

2. *Hemorrhage from the Ears* cannot, of itself, be considered a sign of much importance, as it may arise from any injury which ruptures the membrane of the tympanum, without necessarily implying the existence of fracture. If, however, it be profuse and long continued, the blood which remains in the meatus pulsating, and other symptoms of cerebral injury being simultaneously present, it becomes probable that a fracture of the petrous portion of the temporal bone has occurred, and that the blood proceeds from one of the large venous sinuses in that neighborhood.

The occurrence of a *Discharge of Thin Watery Fluid* from the ear or nose, or through a wound of the scalp, is very significant of fracture: this discharge appears, in most cases, to be due to the escape of cerebro-spinal fluid, though instances have occurred in which the secretion of the tympanic cavity, and even saliva (leaking backwards through a perforation of the meatus, produced by the fragment of a broken jaw), have been mistaken for the characteristic discharge of fracture at the base of the skull. If, however, a profuse watery discharge occur from the ear immediately after the accident, or if it follow a profuse and continued aural hemorrhage, there can be little doubt that the cerebro-spinal fluid is indeed escaping, and that a fracture, therefore, is necessarily present.[1] Watery discharge from the nose is, of course, much less significant, and as an accompaniment of fracture is less often met with than that from the ear. Compound fracture of any part of the cranial vault may be attended by a discharge of cerebro-spinal fluid, provided that there be a communication between the external wound and the sub-arachnoid cavity.

FIG. 164.



Fracture of skull with great loss of substance. (From a patient under the care of Dr. Charles E. Slocum.)

It is stated by Robert, who has given much attention to this subject, that cases of fracture accompanied with discharge of cerebro-spinal fluid are always fatal; this is probably a mistake, for several well-authenticated cases are on record, in which recovery has taken place in spite of the occurrence of these discharges, though, of course, in any case which recovers, there is always the possibility of an error having been made in the diagnosis. A *sudden cessation* of the watery discharge is apt to be quickly followed by fatal coma.

Prognosis.—As far as the injury to the bone is concerned, there is very little risk from fracture of the skull: osseous union commonly occurs without difficulty, unless there has been loss of substance, in which case the gap is filled by means of a firm and dense membrane, as shown in Fig. 164, from a photograph kindly sent me by Dr. Charles E. Slocum, of Defiance, Ohio. If necrosis takes place, the sequestrum is thrown off by a process of exfoliation, and, if both tables of the skull be involved, the dura mater may be seen covered with healthy granulations, and pulsating at the bottom of the wound. Very large portions of the skull may be lost, either at the time of the accident, or at a later period by necrosis, without injury to the patient; and, indeed (paradoxical as it may seem), those cases often appear to do best in which the skull has suffered most extensively, the force of the blow or other injury spending itself, as it were, upon the bone, and the brain escaping with comparatively little harm. The danger in any case of fractured skull depends upon the amount of injury done to the cranial contents, this injury consisting in contusion, laceration, and subsequent inflammation, conditions which have already been considered.

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[1] Roser, however, believes that, if the meninges be ruptured, cerebro-spinal fluid may leak through the pores of the cranial bones without these being broken.

Treatment.—The treatment of a fracture of the skull must have reference to the condition of the cranial contents. The question of trephining in these cases will be most conveniently considered hereafter; after the operation, if it be resorted to, or in cases in which operative measures are not required, the treatment should be conducted on the principles already laid down for the management of cerebral contusion and laceration, and traumatic encephalitis. Cold to the head, opium, purgatives, liquid food, calomel (in cases of arachnitis), with perhaps blisters or local bloodletting, if coma be threatened, will be found the most useful remedies in the majority of these cases. In cases of compound fracture, loose fragments and foreign bodies should be removed if possible, and depressed but adherent portions of skull elevated, provided this can be effected without too much disturbance. The danger is, however, less from compression than from inflammation, and hence rough handling or careless probing of the brain must be rigorously avoided.

Injuries of the Cranial Contents.

Wounds of the Brain and Meninges.—The brain or its membranes may be wounded, and portions of the cerebral mass itself driven out of the skull in cases of fracture, recovery yet ensuing; it is indeed surprising to see what serious wounds may occasionally be inflicted upon the brain and its membranes, without a fatal result. I saw, at Cuyler U. S. A. Hospital, a soldier who had survived a perforating gunshot fracture of the skull, and Dr. O'Callaghan gives the case of an officer, who lived seven years with the breech of a fowling-piece within his cranium; perhaps, however, the most remarkable cases on record, of recovery after wound of the brain, are those narrated by Dr. Harlow and Prof. Bigelow, and by Dr. Jewett; in the former case an iron bar, three and a half feet long, and weighing thirteen pounds, passed through the head, and in the latter, a somewhat similar injury was produced by a gas-pipe.

The *symptoms* and *prognosis* of brain wounds will of course vary with the particular part involved. Lesion of the optic tract may cause blindness; or a wound in the neighborhood of the fourth ventricle, saccharine diabetes. Wounds of the base of the brain are more dangerous, and more quickly fatal, than those of its convexity. The *treatment* of brain wounds consists in the adoption of the measures which have already been so often referred to, as appropriate in all cases of injury to the contents of the cranium.

Hernia Cerebri.—Under this name have been included several distinct conditions, which have merely in common the protrusion of a fungous-looking mass through an opening in the skull. This mass may be merely a collection of coagulated blood, or may consist of exuberant granulations, proceeding from the dura mater or from the wounded brain itself, but the *true hernia cerebri* consists of softened and disintegrated brain matter, mixed with lymph, pus, and blood. The mass projects through the dura mater and skull, and the superficial portions, which slough and are cast off, are usually replaced by fresh protrusions, until the patient dies exhausted. More rarely the patient may recover, the whole projecting mass being disintegrated and removed, or slowly shrinking without the occurrence of sloughing. It was taught by Guthrie that hernia cerebri was more likely to occur through small openings in the skull, than through large apertures. This view, however, is not confirmed by the experience of all observers, and the occurrence of the affection appears to depend more upon the condition of the brain, than upon that of the skull. Hernia cerebri usually manifests itself in the course of the first or second week of the injury, the period varying with that of the development of cerebritis. The *treatment* is that of encephalitis in general. I doubt if advantage can be obtained from any local treatment, though it is said that in the early stages slight pressure has proved useful. Avulsion, excision, and ligation are all to be reprobated, as more apt to add fresh irritation than to be productive of benefit. As the affection seems often to result from the imbedding of spiculæ of bone in the brain, we should be careful to remove all loose fragments that can be detected; while, on the other hand, as hernia cerebri cannot occur without wound of the dura mater, this membrane should be scrupulously respected in all our operations upon the skull.

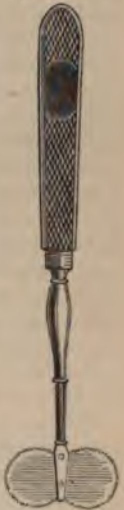
Trephining in Injuries of the Head.

The objects sought to be attained by the use of the trephine are the *removal of compression*, whether caused by extravasation, by displaced bone, or by the presence of pus, and the *prevention of inflammation*, by the removal of foreign bodies, such as sharp spiculæ of bone, musket-balls, etc. Trephining is also occasionally employed in the treatment of *epilepsy*, when it appears probable that the disease is caused by a morbid condition of the skull. Sédillot recommends trephining as a *prophylactic* in many cases of fractured skull, but his views are not shared by surgeons generally.

Trephining for Extravasation.—If it were possible to be sure that the seat of extravasation were between the brain and dura mater, and that there were no other lesions, operative interference might be employed with some hope of benefit. When it is remembered, however, that the seat of extravasation can very rarely be determined, and that these cases are almost invariably complicated with grave injury of the brain substance, it ceases to be a matter of surprise that, as Mr. Hutchinson puts it, "the modern annals of surgery do not . . . contain any cases in which life has been saved by trephining for this state of things." There are, indeed, a few cases on record, in which blood has been evacuated from between the dura mater and skull, or even from the cavity of the arachnoid, the patients recovering; but in the immense majority of instances, the operation, which is now seldom performed under these circumstances, has been useless, or has even hastened death. Hence, I cannot but think that, as a rule, the surgeon will do wisely to abstain from the use of the trephine in these cases, relying upon medical treatment, as in dealing with ordinary apoplexy. If the trephine be employed, a large circle of bone should be removed, in order to give room for the evacuation of coagula, and to afford a fair opportunity to secure any vessel that may be found bleeding.

Trephining for Depressed Bone.—Probably few surgeons, at the present day, would think of operating in a case of *Simple Depressed Fracture*, without symptoms of compression. Even if there be such symptoms, the advantages to be derived from trephining are, at least, very problematical, for (1) the symptoms, if due to the depressed bone, will probably pass off by the brain accustoming itself to the pressure; and (2) if the compression persist, it will, most probably, be found to be due to extravasation from laceration of the brain itself, a condition which evidently would not be benefited by trephining. Indeed, Hutchinson goes so far as to consider compression of the brain as the result of depressed fracture "an imaginary state," and declares that he has "never seen a case in which there seemed definite reason to think that depression produced symptoms." Although the rule is still given, in most of our surgical works, that trephining is indicated in simple fracture accompanied with marked symptoms, there can be no doubt that hospital surgeons are becoming more and more averse to operating in these cases; and for my own part, I can only say that I never seen a case of this kind in which I thought the use of the trephine justifiable, nor an autopsy which showed that the operation could possibly have saved life.

FIG. 165.



Hey's Saw.

With regard to *Compound Depressed Fractures*, it seems to me that the course to be pursued should vary, according as they are or are not *impacted*. In an *impacted* fracture, the depression is necessarily inconsiderable, and if symptoms of compression are present in such a case, they are due to extravasation or laceration, and not to the depression; moreover, the impaction prevents the access of air to the cranial contents, and thus lessens the risk of disorganizing inflammation following the injury. Hence, in impacted fracture, though compound and depressed, I would not advise an operation, even if symptoms of compression were present. For one case like Keate's, in which by a happy accident the operator might discover a wound of a large artery, and thus relieve the compression, there are many cases in which trephining could be productive of no benefit, but would, by admitting the atmosphere, seriously complicate the prospects of recovery. If, however, in a case of compound impacted fracture, convulsions or other symptoms of cerebral irritation come on at a later period, the surgeon should explore the wound, and if it appear that suppuration has occurred *between the tables of the skull*, may properly apply the trephine, as I have myself done with advantage under these circumstances. In the case of a *non-impacted* fracture, the rule has already been given, to remove the loose fragments, and elevate the remainder. In most cases this can readily be done by means of the elevator and forceps, without enlarging the opening in the skull. If, however, the aperture be too small to admit of safe manipulation, there can be no objection to enlarging it, either with a Hey's saw, with cutting pliers, or with a small trephine. The risks of atmospheric contact are unavoidable in such a case as this, and the best that the surgeon can do is to clear the wound as well as possible, by the removal of osseous spiculæ and foreign bodies. It will thus be seen that I would restrict the use of the trephine within very narrow limits; it is not to be used with the idea of relieving compression, nor with the idea that there is any special virtue in the operation, to prevent encephalitis. The trephine should be used merely as Hey's saw is used, mechanically, to enlarge an opening which would be otherwise too small to allow the surgeon to carry out plain therapeutic indications. The surgeon should cautiously explore every compound non-impacted fracture, and if there be loose spiculæ, remove them, whether there be symptoms of compression or not. As the inner table is often more extensively involved than the outer table (especially in punctured fractures), it may be necessary slightly to enlarge the opening in the skull in order to remove these spiculæ, and this enlargement may be done with or without the trephine, according to the nature of the case. All this must be accomplished, however, with the utmost caution and gentleness; and I believe, with Brodie, that it is better to leave, imbedded in the brain, a foreign body, or even a fragment of bone, than to add to existing irritation by reckless attempts at its removal.

Trephining for Intra-cranial Suppuration.—Some years ago, under the influence of the teaching and example of the celebrated Percival Pott, this operation was more frequently resorted to than it is at the present day. As we have already seen, there is, in the large majority of cases, no symptom which renders it certain that pus is present; and, as Hutchinson remarks, if we adopt the rule of trephining in all cases in which, after bruise or fracture of the skull, the patient has become hemiplegic or comatose, with inflammatory symptoms, we will operate in twenty cases of arachnitis, for one in which we will find any pus to be evacuated; while even if pus be found, and can be removed, in the immense majority of cases arachnitis will coexist, and cause death in spite of the operation. "I have repeatedly," says Hewett, "seen the trephine applied under such circumstances, and matter evacuated, but without any permanent benefit. Indeed, the successful issue of a case of trephining for matter between the bone and dura mater is, I believe, all but unknown to surgeons of our own time." When the chances of a successful issue after operative measures are so slight, the surgeon will, I think, in most cases, do wisely to abstain from the operation;[1] more especially as these cases will occasionally recover, at least temporarily, under expectant treatment. Even if pus be present, it is impossible to know that it is within reach, and cerebral abscess may continue for many years, producing little or no disturbance; while, though recovery has occasionally followed trephining under these circumstances,[2] the operation has in many more cases but superadded a new injury to those already existing. Chassaignac has proposed to trephine as a *prophylactic against pyæmia,* in cases of contused skull; but the operation is surely not justified, either by experience, or by what we know of the etiology of the affection meant to be prevented.

With regard to *Trephining for Epilepsy,* I can only say that I consider the operation usually unadvisable.[3] Its risks are not inconsiderable, 16 out of 72 cases collected by Billings, and 28 out of 145 collected by Echeverria, having proved fatal; and when we remember the well-known fact that epilepsy is *apparently* and *temporarily* curable by very various remedies, which have at least the merit of being harmless, we should pause before recommending an operation which may not improbably itself cause death, and of which the prospective benefits, as regards permanence, are certainly doubtful.[4]

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[1] Unless, as in cases successfully trephined by P. H. Watson, N. R. Smith, and Cras, an orifice in the skull should plainly communicate with an intra-cranial abscess. Under such circumstances, if the opening were insufficient, the operation would of course be indicated.

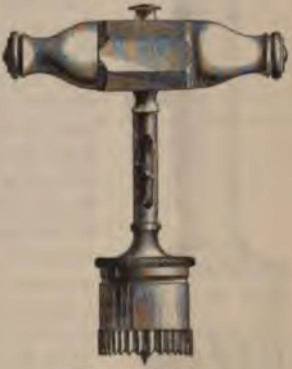
[2] See page 319.

[3] According to Broca, in epilepsy from cranial injury, the temperature is raised upon the affected side; hence, if the temperature be highest on the uninjured side, then epilepsy is not due to traumatic causes, and will not be relieved by an operation.

[4] Broca and Championnière have given rules for selecting the point of trephining by "localizing" the seat of cerebral injury. I hope that I may be pardoned for expressing the opinion that their interesting investigations are more ingenious than practically useful.

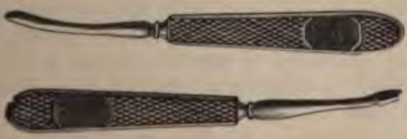
Operation of Trephining.—The form of trephine ordinarily employed is shown in the accompanying illustration (Fig. 166). It is to be applied evenly on the surface of the skull, with the centre pin[1] slightly projected, and is to be worked cautiously by light turns of the wrist from left to right and from right to left, until a groove is formed, when the centre pin must be withdrawn, lest it puncture the skull and wound the dura mater. The surgeon then proceeds slowly and gently, brushing away the bone-dust, from time to time, and testing the progress made by means of a fine probe or toothpick. When the diploë is reached (if there be any), the trephine works more freely, and blood escapes with the bone-dust. As the inner table is approached, the surgeon must renew his precautions, lest undue pressure, or an accidental slip of the instrument, should wound the dura mater, an occurrence which would be very apt to prove fatal. The disk of bone which has been separated will often come away in the crown of the trephine, or may otherwise be readily removed with the elevator (Fig. 167) and forceps. If the external wound be not large enough to allow the application of the trephine, more room may be afforded by means of a crucial or T incision, the flaps of the scalp being held out of the way, and carefully replaced when the operation is completed. The wound should then be lightly dressed, and the constitutional treatment of the patient carried out in accordance with the principles already laid down for the management of cerebral injuries. There are certain regions of the skull to which the trephine should not be applied, if it can be avoided; these are the various sutures, the lines of the large venous sinuses, the anterior inferior angle of the parietal bone (where there would be risk of wounding the middle meningeal artery), and the frontal sinus; if it should be necessary to operate in the latter situation, the outer table should be removed with a large trephine, and the inner table with a smaller instrument.

Fig. 166.



Common trephine.

Fig. 167.



Different forms of elevator.

The *Conical Trephine* (Fig. 168) is an old instrument, the use of which has been, in modern times, revived by Galt, of Virginia. It has the advantage over the common instrument, that its peculiar shape prevents the possibility of its unexpectedly plunging into the brain; it, however, has the disadvantage that it divides the skull obliquely, and thereby exposes the part to greater risk of necrosis.

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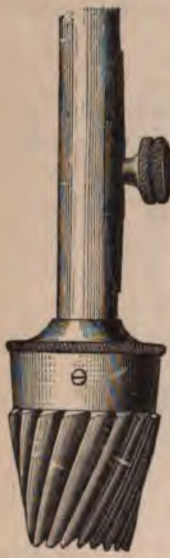
[1] If the use of the centre pin be undesirable, the crown of the trephine may be steadied by applying it through a piece of perforated pasteboard, as suggested by Dr. P. H. Watson, of Edinburgh.

Fig. 168.



Conical trephine.

The *results* of the operation of trephining are very unfavorable, the proportion of recoveries having been in the New York Hospital only about 1 in 4, and in University College Hospital (London) 1 in 3, while in Paris almost every case operated on of late years, has, according to Nélaton, proved fatal. I have myself been compelled to trephine in 9 cases, but in only 1 has the operation been followed by permanent recovery. The majority of deaths after trephining are, however, due, not to the operation, but to cerebral lesions on which the operation could have no effect, so that statistics are yet wanting to show the absolute mortality of the operative procedure. In only one of my own nine cases did the operation seem to hasten death, while in two which ultimately proved fatal great relief was afforded, and life was prolonged for several weeks. One case ended in complete recovery, and in the remaining five the effect of the operation appeared to be entirely indifferent. During our late war, 227 terminated cases of trephining gave 126 deaths and 101 recoveries; 451 cases of removal of splinters or elevation of fragments, without trephining, gave 176 deaths and 275 recoveries; while 3447 cases treated by expectancy gave 2159 deaths and only 1288 recoveries. (Otis.) As, however, the latter group of cases contained almost all the instances of penetrating and perforating fracture, as well as those which proved fatal before any treatment could be adopted, it would be manifestly unfair to found upon these statistics any argument as to the value of the operation of trephining.

The most elaborate statistics of trephining yet published are those of Dr. Bluhm, who has collected 923 cases, with 450 recoveries and 473 deaths, a total mortality of 51.25 per cent. The death-rate varies according to the period at which the operation is performed, the *primary* cases being the most fatal. The following table is condensed from that of Dr. Bluhm, in Langenbeck's Archives (Vol. XIX., Part 3).

	Total.	Recovered.	Died.	Mortality, per cent.
Primary, ...	114	51	63	55.26
Secondary,.	158	94	64	39.24
Late, ...	59	39	20	33.90
Period unknown, ...	592	266	326	55.07
Aggregate, ...	923	450	473	51.25

Perhaps we can most nearly approach a correct estimate of the risks of the operation itself, by considering Billings's and Echeverria's statistics, already referred to, of trephining for epilepsy. In these cases the only *traumatism*, to borrow a Gallicism, is that due to the operation itself, and here we find that the mortality is about 20 per cent. But, even with this comparatively small figure, it behooves the surgeon to be very cautious not unnecessarily to employ an operation which of itself kills one out of every five patients, more especially as, upon consideration of the pathology and natural history of brain injuries, the probability of benefit from the operation is seen to be limited to an exceedingly small number of cases.

CHAPTER XVI.

INJURIES OF THE BACK.

Wounds or other injuries of the soft tissues of the back present no peculiarities requiring special comment. It is, indeed, only in consequence of the liability of the vertebral column and its important contents to be involved in lesions of the back, that injuries of this region acquire the interest which they possess in the eyes of the surgeon. In entering upon the important subject of spinal injuries, I shall consider, first, the traumatic lesions of the spinal cord itself, reserving for a later page what I have to say with regard to sprains, fractures, and dislocations of the vertebral column.

Injuries of the Spinal Cord.

Concussion of the Spinal Cord.[1]—This may vary, like concussion of the brain, from the slightest jarring or shaking, up to complete disorganization. Unlike concussion of the brain, however, it is very seldom that the spinal injury is so severe as to prove immediately, or even rapidly, fatal (except when accompanied by fracture or dislocation), death as a result of spinal concussion usually occurring after a considerable interval, and being preceded by inflammation of the spinal meninges or of the cord itself, or by progressive softening without inflammatory symptoms. The reason for this difference is, as pointed out by Lidell, Shaw, and others, that the spinal cord floats loosely in an elastic medium (the cerebro-spinal fluid), and is therefore not so readily exposed to injury as the brain, which fits comparatively closely to its bony investment. I do not believe it possible for death to occur from concussion of the spinal cord, without lesions demonstrable by *post-mortem* inspection. Though several cases have been recorded by Boyer, Frank, and others, in which such an event has been supposed to occur, it is probable that, with the more accurate means of examination which are now possessed, positive lesions could have been discovered. Death may, of course, occur from *shock*, which is an occasional complication of spinal injuries; or from concomitant lesions of other organs—lesions which may readily escape detection, if attention be directed chiefly to the condition of the spine.[2] The post-mortem appearances, in fatal cases of spinal concussion, may be classed as (1) extravasation of blood—which may occur in the substance of the cord itself, between the cord and its membranes, or between the latter and the vertebral column; (2) laceration of the membranes, or of the cord; (3) inflammatory changes—meningitis or myelitis—with or without compression of the cord from the so-called products of inflammation, lymph, pus, etc.; and (4) degeneration of the structure of the cord, without any evidences of pre-existing inflammation.

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[1] The term *concussion* is retained from motives of convenience. It is not, however, scientifically correct, the various conditions which are designated by the term concussion, being really instances of contusion, partial rupture of the cord fibres, etc. See remarks on *Concussion of the Brain*, in Chap. XV.

[2] See, in connection with this subject, an interesting paper by Dr. W. Moxon, on thrombosis of the renal vessels through injury to the lumbar spine (*Guy's Hosp. Reports*, 3d s., vol. xiv., pp. 99–111).

Hemorrhage into the Vertebral Canal is a not unfrequent occurrence in severe cases of spinal injury. If in small amount, it may give rise to but transient paralysis, the effused blood becoming coagulated and partially absorbed, and the compressed cord becoming gradually accustomed to its presence; in other cases it may remain in a fluid condition, or may possibly be clotted and subsequently reliquefied. In some cases it would appear that slow extravasation may continue for a considerable period, fatal paralysis not coming on for some time after the injury (in Mr. Heaviside's case nearly a year), and death thus resulting, as pointed out by Aston Key, from the *cumulative* effect of spinal compression. I do not know of any sign by which the surgeon can positively determine the exact seat of extravasation in cases of spinal hemorrhage; in the majority of instances the effused blood is found outside of the membranes, or between the latter and the cord; and it is probably in one of these positions that extravasation usually occurs, when the symptoms are slow and progressive in their development, and when the power of motion is more affected than that of sensation. Extravasation into the substance of the cord itself, would probably cause instant paralysis, both motor and sensory, which might be permanent, or in a favorable case might subsequently disappear. This is the most plausible explanation of the symptoms in the remarkable case recorded by Hughes, of Dublin, in which an injury of the cervical spine caused instant but temporary loss of both motion and sensation, in the lower extremities, followed by gradually developed but long-persistent *motor* paralysis, in the upper extremities. Instant loss of both motion and sensation, if temporary, may be supposed to be due to a slight hemorrhage into the substance of the cord itself; while gradually developed paralysis, especially affecting the motor power, may be reasonably attributed to hemorrhage upon the surface of the cord, or even outside of the membranes. The upper limit of paralysis will, of course, indicate clearly the *height* at which the extravasation has occurred.

Laceration or Rupture may occur in the spinal membranes (particularly the pia mater, allowing a hernia of the medulla), or in the fibres of the spinal cord itself. These lesions are, however, more frequently produced by violent twistings or bendings, or by fractures or dislocations of the spinal column, than by any injury to which the term concussion can be properly applied.

Inflammation of the Spinal Membranes (Meningitis), and of the Cord (Myelitis), are very frequent secondary occurrences in cases of spinal injury. In spinal meningitis there is great congestion, and often effusion of serum, or formation of lymph or pus. Myelitis may affect the whole thickness of the cord, or principally the gray matter; though, if consecutive to meningitis, the white portion may alone be involved. Inflammation of the cord substance is commonly attended with softening, which may end in total disappearance of the nervous structures at the part affected—nothing but connective tissue remaining; more rarely induration occurs, the nervous substance being increased in bulk, and of a dull whitish color. The occurrence of inflammation, in cases of spinal injury, is attended with great pain, distressing sensations, as of a cord tied around the waist or limbs, tetanic spasms, general convulsions, etc.

Progressive Disorganization of the Cord may occur as the result of injury to the spine, without the manifestation of any evidence of inflammation, either during life, or upon post-mortem inspection. Paralysis, both motor and sensory, sometimes accompanied with muscular rigidity, gradually creeps upwards, until death ensues from interference with the respiratory function. The autopsy shows diffused white softening of the spinal cord, without evidence of either meningitis or myelitis. In other instances the cord, to the unaided eye, appears perfectly healthy, though marked changes are subsequently discovered by careful microscopic inspection (H. C. Bastian, *Med.-Chir. Trans.*, vol. l., pp. 499–542).

Wounds of the Spinal Cord.—The spinal cord may be wounded by sharp-pointed or cutting instruments, by pistol-balls, etc., without any, or with very slight injury to the vertebral canal. The symptoms of such a lesion are those which we shall presently consider as common to all spinal injuries, though there may be some modifications, owing to the greater limitation of the injury to certain parts of the cord than in cases of spinal concussion, or of vertebral fracture or dislocation; thus, while in the latter classes of cases paralysis is usually bilateral, and involves both motion and sensation, in cases of wound of the cord we not unfrequently find paralysis only of the side injured, as in instances recorded by Vignés, Peniston, and others; or loss of motion on the injured, and loss of sensation on the opposite side, as in cases narrated by Boyer, and by Hughlings Jackson.

Symptoms of Spinal Injuries.—The following account of the symptomatology of injuries of the spine is to be understood as applying to all forms of injury in which the cord is involved, whether the vertebral column itself has or has not escaped: as we shall see hereafter, the differential diagnosis of the various forms of spinal injury is often impracticable, and always difficult, a fact which is not surprising when we reflect that the *rational* symptoms are the same in the various forms of lesion. I shall adopt the classification of symptoms which I employed in my monograph on Injuries of the Spine, published in 1867, and which is pretty much the same as that used by Brodie, in his classical paper in the *Medico-Chirurgical Transactions*, vol. xx.

Motor Paralysis.—The most striking, and probably the most constant, symptom in cases of spinal injury, is paralysis of the voluntary muscles below the seat of lesion. When the injury is below the second lumbar vertebra, there may be no paralysis, or, if it exist, it is usually partial and temporary, the spinal cord itself not usually extending below this point, and the cauda equina appearing to be comparatively free from risk of injury. In lesions below the eleventh dorsal vertebra, the paralysis is usually less complete than in those at a higher point, the cord being protected in this part by the roots of the cauda equina. Paralysis, ordinarily, does not extend to parts which derive their nervous supply from the portion of the cord above the seat of injury, and the exact point of lesion can be thus determined in most cases; the apparent exceptions reported by Stafford, Brodie, and others, are probably explicable by the fact that a second lesion, such as contusion or extravasation, existed at the higher point, as the result of indirect violence to which the older writers would have given the name of counterstroke. The extent of the spinal lesion in a downward direction, may be determined by means of the electrical test, proposed by M. Landry. This surgeon found, in a case of luxation of the fifth dorsal vertebra, that the muscles of the thigh ceased to respond to electricity, while those of the leg, though equally paralyzed, continued to contract in response to the electric stimulus. The autopsy showed that the part of the cord which supplied nerves to the femoral muscles was disorganized, while that whence arose the nerves going to the leg was quite healthy. Thus the fact that each segment of the cord constitutes a separate nerve centre, affords a means of accurately determining the extent of that portion which has been injured. Motor paralysis is usually symmetrical;

when unilateral (as in a case of fractured spine observed by Liston), it indicates that one side only of the cord is involved, as in the instances of wound of the cord already referred to. Motor paralysis after spinal injuries may be due to various causes, as to division of the cord fibres, to compression (either from extravasation, or from the products of inflammation), or to progressive disorganization of the nervous structures. If the paralysis be immediate, complete, and permanent, the cord is probably divided; if the paralysis be immediate, but not permanent, the case is one of so-called "concussion"—the lesion probably being a slight extravasation into the substance of the cord, though this is, of course, mere matter of conjecture; paralysis coming on gradually, and subsequently diminishing, is probably due to compression on the surface of the cord, from extravasation or from inflammatory changes; while slowly but continually extending paralysis gives reason to fear progressive disorganization of the cord—a condition which, almost always, ultimately proves fatal.

A few cases are referred to by Velpeau, in which the cord is said to have been completely divided, without any paralysis having existed during life; it is scarcely necessary to say that these cases admit of but two explanations—either, as believed by Brodie, that they were incorrectly observed, the division of the cord fibres not being complete—or, as suggested by Prof. Brown-Séquard, that the division was at a point below the origin of most of the spinal nerves.

Muscular Spasms or Convulsions after spinal injuries were believed by Brodie to indicate compression of the cord, and I believe this statement to be correct, as regards the spasms met with in the early stages of these cases. The value of this symptom for diagnostic purposes is, however, diminished by the fact that the cord is often found compressed, after death, without spasms having been observed during life. The occurrence of convulsions, at a later period (as already mentioned), may denote the onset of spinal meningitis; while again, in cases which recover, muscular twitchings not unfrequently accompany the return of motor power.

Loss of Sensation usually accompanies and is coextensive with motor paralysis, in injuries of the spine. So complete was the loss of feeling in a case recorded by Purple, that the patient submitted to amputation of both thighs, without the use of an anæsthetic, and without manifesting any emotion during the operation. Occasionally sensory precedes motor paralysis, while, on the other hand, in favorable cases, the power of feeling is not unfrequently regained while that of motion is still very imperfect.

Hyperæsthesia is occasionally observed in connection with motor paralysis. South saw a case of fracture of the cervical spine in which there was loss of motion with hyperæsthesia on the right side, and anæsthesia on the left. On the other hand, in a case reported by Gama, intense hyperæsthesia followed a bayonet wound of the posterior columns of the spinal cord, there being absolutely no paralysis; a circumstance which, as pointed out by Brown-Séquard, would indicate that the anterior portion of the cord had escaped injury. A zone of hyperæsthesia sometimes marks the upper limit of sensory paralysis, due probably to irritation of the spinal nerves, before their exit from the vertebral canal.

Pain is a symptom of frequent occurrence in spinal injuries; it may be felt at the seat of lesion, or may be referred to various other parts of the body. Unusual and often most distressing sensations, as of burning, constriction, etc., may be referred to parts, the nervous connection of which with the sensorium is entirely destroyed.

Dyspnœa.—This is a marked and distressing symptom of injuries of the cervical and upper dorsal regions of the spine. It is often said that, in lesions of the cervical cord, respiration is performed by the diaphragm alone; this is not strictly correct, for, as pointed out by Shaw, in many cases the diaphragm is helped by the serratus magnus muscle (supplied by the external thoracic nerve, which, when the shoulders are fixed, tends to lift and expand the chest. If the spinal cord be destroyed above the origin of the phrenic nerve, death is instantaneous. The occurrence of dyspnœa in *dorsal* injuries depends upon two causes: first, the abdominal muscles being paralyzed, the act of expiration is necessarily incomplete; and, secondly, paralysis of these muscles allows the bowels to become distended with gas, thus thrusting the diaphragm upwards, and mechanically impeding its motion. The occurrence of dyspnœa at a late period of spinal injuries is attributable to progressive disorganization of the cord extending upward to the cervical region.

Dysphagia and *Vomiting* have been observed in injuries of the cervical spine, as has *Jaundice* in those of the dorsal region, without any hepatic lesion having been discovered after death.

Involuntary Fecal Discharges are met with in those cases in which the injury has involved the lowest portion of the cord—that which presides over the sphincter muscle of the rectum; when the lesion is at a higher point, this part, having escaped injury, continues to act, for a time at least, as a separate nerve centre, and *Costiveness* ensues. In some cases there may be temporary fecal incontinence, depending on shock, which is coincident with, though not necessarily dependent upon, the spinal lesion.

Retention of Urine is present in most cases of spinal injury, being followed after a time by *Overflow*, and subsequently by true *Incontinence*. A few cases are recorded by Morgagni and others, in which incontinence was present from the outset.

Suppression of Urine is a more serious, but fortunately a rarer, symptom than *retention*. Several remarkable instances of this occurrence have been recorded by Brodie, Dorsey, Comstock, and others.

Hæmaturia, from coincident contusion or partial lacertion of the kidneys, is not unfrequently met with in cases of sprain of the lumbar spine. This symptom is not usually one of serious import, though Mr. Shaw reports a case in which the bleeding was so profuse as to render the patient anæmic. There is, according to Le Gros Clark, no reason to believe that organic disease of the kidney ever ensues in these cases.

Glycosuria has been met with in connection with injury of the cervical spine; the circumstance is interesting, in view of the experiments which have been made as to the artificial production of diabetes.

Change in the Urine Occurring after Spinal Injuries.—Within a short time, varying from the second to the ninth day after a severe injury to the spine has been received, the urine, from being clear and acid, becomes turbid, ammoniacal, and loaded with mucus, and at a later period with phosphate of lime. This condition may continue indefinitely, or may disappear, or acidity and alkalinity of the urine may alternate, without any very obvious reason. In some rare cases, according to Brodie, the urine first secreted after a spinal injury, though acid, and free from mucus, has a peculiarly offensive and disgusting odor. In other cases it is highly acid, having an opaque yellow appearance, and depositing a yellow amorphous sediment, which, in one instance, stained the mucous membrane of the bladder, though the latter presented no marks of inflammation.

Cystitis is an almost constant sequence of severe spinal lesions; it is probably due, chiefly, to the mechanical injury to the bladder from over-distention and the frequent use of the catheter, but is, no doubt, further aggravated by the altered character of the urine. This alteration, however, is itself usually secondary, depending on the inflamed state of the lining membrane of the bladder, though, in some cases, according to Hilton, the urine is alkaline as it comes from the kidneys.

Priapism.—This curious symptom is occasionally met with in connection with lesions of all portions of the spinal cord, except the lowest. It is totally unconnected with any voluptuous sensation, and is only found in cases accompanied by motor paralysis. In some cases, particularly when the injury is in the cervical region, priapism may occur spontaneously, immediately after the accident, and is then due (as pointed out by Hilton) to the excito-motor function of the portion of the cord below the lesion being unduly excited, because deprived of the regulating influence of the brain. In other instances this symptom is developed—also spontaneously—at a later period, owing to central irritation, generally from slight extravasation into the substance of the cord; while in still other cases it occurs merely as a reflex phenomenon, and may be excited by touching the scrotum, or by passing the catheter. The existence of priapism is usually evidence of severe and permanent injury to the spinal cord, though that this symptom may occur in connection with simple concussion is shown by a case recorded by Le Gros Clark, in which sensation returned on the ninth day, though the power of motion was not restored for several months.

Flushed Face, usually accompanied by *Lachrymation,* and by *Contracted* or merely *Myotic Pupils,* is, I believe, only met with in cases of injury involving the cervical portion of the cord. It appears to be due to a partial paralysis of the sympathetic nerve, which derives its cervico-cephalic branch from the so-called "cilio-spinal region" of the spinal cord. This symptom is one of very grave import.

Alteration of Vital Temperature is a symptom which has been particularly investigated by Chossat and Brodie. The temperature of the paralyzed parts frequently rises much above the normal standard, this symptom being probably most frequent in lesions of the upper portion of the cord, though a temperature of 100° has been noted by Hutchinson, in a case of fracture of the lumbar spine. In a case of injury of the cervical region, observed by Brodie, the thermometer placed between the thighs rose to 111° Fahr., and this elevated temperature persisted even after the patient's death.[1] This symptom, to which Hutchinson gives the name of *Paralytic Pyrexia,* is probably due, like the flushing of the face, to a paralyzed condition of the sympathetic or vaso-motor nerve. Persistent elevation of temperature, in spinal injuries, is a very grave symptom, and always affords grounds for a gloomy prognosis. In the later stages of spinal injuries, the temperature of the paralyzed parts often becomes greatly reduced;[2] and even when there is no real diminution of temperature, the patient often experiences a distressing sensation of coldness.

Nutritive Changes in Paralyzed Parts.—In patients who survive the first risks of spinal injury, the paralyzed extremities usually, but not always, become flabby and atrophied; the skin assumes a sallow hue, and often desquamates in flakes; the joints are often contracted and stiff. Partly from the lessened vitality of the tissues, but more particularly from the patient's insensitiveness to pain and inability to change his position, gangrene and sloughing are apt to occur in parts that are exposed to pressure; large bed-sores are thus formed over the sacrum, hips, knees, or any part that touches the bed, and may slowly exhaust the patient's strength, or, more rarely, may give rise to pyæmia, and thus quickly induce a fatal result. Bed-sores are most frequently met with in cases of injury of the lower portion of the cord, simply, I believe, because in these cases life is more often prolonged than when the upper part of the spine is involved.

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[1] J. W. Teale has reported a case of spinal injury in which the temperature is said to have ranged during nearly nine weeks from 108° to 125° Fahr., and in which the patient ultimately recovered; but, as in cases recorded by Schliep, Sellerbeck, Mahomed, and S. Mackenzie, deception may have been practised by the patient making friction upon the bulb of the thermomter, or in other ways. Dr. Donkin has collected eight cases of various kinds in which recovery followed, though the temperature ranged from 108° to 117° Fahr. In a case of spinal concussion under Dr. Little's care, in the Adelaide Hospital, Dublin, the temperature is said to have risen to 133.6° Fahr., without evil result to the patient.

[2] Temperatures of 82° Fahr., 81.75° Fahr., and 80.6° Fahr., were observed in fatal cases reported by Van der Kolk, Wagstaffe, and Nieden. Kosürew has recorded a fatal case of *cranial* injury, in which the temperature ranged from 79.7° Fahr. to 84.2° Fahr.

Tetanus, contrary to what might *a priori* be expected, is rarely met with in cases of spinal injury; in a case at St. Thomas's Hospital, it occurred three weeks after a blow on the spine, the patient recovering; while in one of seven cases which occurred during our late war, the autopsy showed, in addition to the spinal lesion, a contusion of the anterior crural nerve. Tetanus followed a punctured wound of the cord in a case observed by Tadlock, of Tennessee.

Cerebral Complications.—Concussion of the Brain may complicate injuries of any portion of the spinal cord, resulting either from direct violence simultaneously inflicted on the head, or from counterstroke. *Delirium, Coma,* and *Insomnia*, have each been occasionally noted in cases of spinal injury; the latter symptoms, however, I believe, only in instances in which the cervical region has been involved. *Cerebral Meningitis*, as observed by Ollivier, often complicates inflammation of the spinal membranes.

Concussion of the Spine from Indirect Causes; Railway Spine.—Under these, or similar names, is described by Erichsen, and other English surgeons, a peculiar morbid condition characterized by very varied nervous symptoms, both physical and mental, which, according to these authors, are all directly traceable to the state of the spine. This subject has excited a great deal of interest, and a great deal of controversy, chiefly because of the numerous suits for damages, which have been brought against railway companies, on account of alleged injuries received in collisions. The *symptoms* appear to be rather those of general nervous prostration and debility, than the definite spinal symptoms which have been discussed in the preceding pages, and are often accompanied by remarkable perversions of the special senses, double vision, photophobia,[1] tinnitus aurium, loss of tactile sensibility, etc. Many of the symptoms resemble those of ordinary progressive locomotor ataxia. "The *state of the spine*," says Mr. Erichsen, "will be found to be the real cause of these symptoms. On examining it by pressure, by percussion, or by the application of the hot sponge, it will be found that it is painful, and that its sensibility is exalted at one, two, or three points. These are usually the upper cervical, the middle dorsal, and the lumbar regions. The exact vertebræ that are affected vary necessarily in different cases; but the exalted sensibility always includes two, and usually three, at each of these points. It is in consequence of the pain that is occasioned by any movement of the trunk in the way of flexion or rotation, that the spine loses its natural suppleness, and that the vertebral column moves as a whole, as if cut out of one solid piece, instead of with its usual flexibility." Other writers of eminence are disposed to doubt the necessary connection of these symptoms with any particular morbid condition of the spine, looking upon "these cases of so-called railway spinal concussion as, generally, instances of

[1] Hyperæmia of the optic disk has been observed by W. Bruce Clark.

nervous shock, rather than of special injury to the spinal cord."[1] There is, as far as I know, but one case in which the post-mortem appearances after death from "railway concussion" have been recorded, and that is Mr. Gore's case, which has been successively published by Dr. J. Lockhart Clarke, Mr. Erichsen, Mr. Le Gros Clark, and Mr. Shaw. The condition of the cord in this case closely resembled, as pointed out by Le Gros Clark, that which, according to Dr. Radcliffe, is found in ordinary cases of locomotor ataxia, so that there is at least room for suspecting, with Mr. Shaw, that the spinal injury was a mere coincidence—particularly as Mr. Gore, the attending surgeon, did not see the patient until a year after the injury. "On the whole, it may be affirmed," says Mr. Shaw, "that what is most wanted for the better understanding of those cases commonly known under the title of 'concussion of the spine' is a greatly enlarged number of post-mortem examinations. Hitherto our experience has been derived almost wholly from litigated cases, deformed by contradictory statements and opinions; and the verdicts of juries have stood in the place of post-mortem reports." In view of the great obscurity which is thus seen to surround this subject, I think that the surgeon will do wisely to exercise great caution in declaring that a patient is suffering from "concussion of the spine from indirect causes," whether the result of railway, or of other injury; at the same time there can be no doubt that grave morbid changes in the spinal cord do result from comparatively slight blows upon the back, and, of course, in a railway collision, it is very possible that an injury might be received, which would induce such changes. This fact has long been recognized in a general manner, but is clearly proved by a case which Dr. H. Charlton Bastian has published in the fiftieth volume of the *Medico-Chirurgical Transactions*, and which has been already referred to (see page 331).

INJURIES OF THE VERTEBRAL COLUMN.

Sprains.—When we consider the number of joints in the vertebral column (nearly eighty), it is not surprising that twists and sprains in this part are occasionally met with, but rather that they are not more frequent than experience shows them to be. The part of the spine most exposed to sprains is the lumbar region, next the cervical, and lastly the dorsal, which is rarely affected. Apart from the risk of concomitant lesion of the cord, these injuries, though quite painful, are not commonly attended with danger. They may be caused by various forms of accident, as by falls or sudden twists, and are not unfrequently met with as the result of railway collisions. The *symptoms*, provided that the cord be not involved, are those of sprains in other parts of the body, local tenderness, pain on motion, etc. In most instances the ligamentous and other affected tissues gradually return to a healthy condition, but under other circumstances, if great stretching and laceration have occurred, permanent weakening of the part may ensue, requiring the constant employment of artificial means of support. An occasional but more dangerous consequence is the extension of inflammation to the structures within the vertebral canal, fatal meningitis or myelitis thus sometimes supervening upon what at first was a simple sprain. In other instances, particularly in the case of the occipito-atloid and atlo-axoid articulations, the accident becomes the exciting cause for the development of chronic disease (white swelling) of the joint, an affection which in this situation may prove suddenly fatal, through the occurrence of secondary dislocation. The *treatment* of vertebral sprains, unaccompanied by cord lesion, is essentially that of sprains in other parts of the body.

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[1] Le Gros Clark, Lectures on the Principles of Surgical Diagnosis, etc., p. 152.

Rest, mechanical support, soothing applications at first, and at a later period stimulating embrocations, with friction, and perhaps the cold douche, will usually be found sufficient to effect a cure. It is often desirable to continue the use of mechanical means of support, such as a moulded gutta-percha splint, or leather belt, for some time after apparently complete recovery. The treatment of the cord complications, when present, is the same as in other forms of spinal injury, and will be considered when we have disposed of the remaining varieties of mechanical injury to the vertebral column.

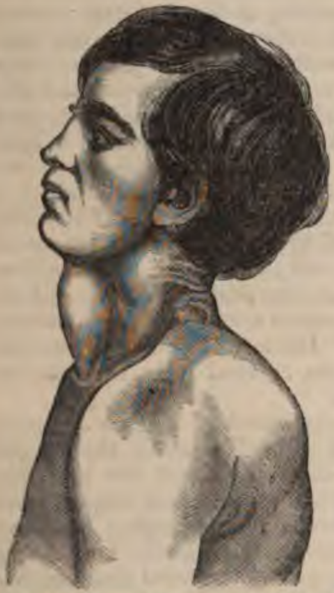
Fractures and Luxations of the Vertebral Column.—I shall consider these two forms of spinal injury together, because, in the first place, they are very commonly associated in the same case, and because, secondly, it is often quite impossible to determine whether a given injury of the spine be a fracture or a dislocation, until a post-mortem examination reveals the exact nature of the lesion. The possibility of luxation occurring in the vertebral column has been denied by many surgeons, and Sir Astley Cooper, with his large experience, declared that he had never met with a case of this nature; other writers, however, have considered them comparatively frequent, and Mr. Bryant says that of seventeen autopsies made at Guy's Hospital in cases of spinal injury, during six years, no less than six showed the lesion to have been pure dislocation. I have not myself met with any instance of absolutely uncomplicated spinal dislocation, but the elaborate tables which I have published in the monograph already referred to, show that 124 of 394 recorded cases of spinal injury were believed by the surgeons who reported them to have been of this nature. I cannot help suspecting, however, that in many, if not most, of these cases there was some slight bone lesion which escaped attention, so that perhaps the term diastasis would, in many instances, be more strictly applicable than dislocation. The large majority of reported cases of vertebral luxation have involved the cervical spine, the smallest proportion being found in the lumbar region.

Causes.—The causes of these injuries of the vertebral column are very various: in most of the instances met with in civil practice, the alleged causes have been falls or blows, acting sometimes by direct, but probably more often by indirect violence. In the cervical region, these injuries have resulted from falls upon the head or the buttocks, from plunging headlong into shallow water, from falls in turning somersaults, from the head being twisted in executions by hanging, etc. It is popularly believed that hanging usually causes death by dislocating the cervical spine—breaking the neck, as it is called—but this is an error. Unless the head be after suspension wrenched to one side (as, according to Louis, was formerly done by the Lyons hangman, who sat on the shoulders of his victims, and twisted their necks until he heard a crack), dislocation does not commonly occur. Fractures and luxations of the vertebræ are, as might be expected, more frequent among men than women, in the proportion of nearly seven to one. No age is entirely exempt from these injuries, though most cases occur among those in early adult life. Maschka has recorded a case of dislocated axis, in a child killed by its mother, when it was only eight days old, while Arnott saw a fracture of the same bone, produced by falling down stairs, in a man aged seventy-four.

Symptoms.—The *rational* symptoms of vertebral fracture and dislocation are due to the accompanying lesions of the spinal cord, and are those which have already been described as common to all forms of spinal injury. The *physical* signs, or those which are peculiar to the mechanical disturbance of the vertebral column, are deformity, increased or diminished mobility, and crepitus. *Local pain* and *tenderness on pressure*, though often present in these cases, are in no wise distinctive, for they are frequently more strongly marked in sprains than in these more serious injuries.

(1.) *Deformity* is usually more perceptible in the dorsal or lumbar, than in the cervical region. A *depression* in the position of one or more spinous processes may be generally taken to indicate fracture, which may involve the vertebral arches, or merely the spinous processes themselves. Fracture of the body of a vertebra, by allowing the approximation of the vertebræ above and below, usually causes *angular deformity* marked by undue *prominence* of the spinous process of the affected vertebra, or of that next above. *Rotatory deformity*, or twisting of the spinal column upon its long axis, may be considered indicative of luxation, which may or may not be accompanied by fracture: it is seldom recognized, I believe, during life, except in the cervical region. *Bilateral dislocation*, an injury almost exclusively confined to the neck, would be marked by angular deformity, and, if in a backward direction, probably could not in most cases be distinguished from fracture of the vertebral body. Though deformity, when present, is probably the most significant of all the physical signs of these varieties of injury, its absence by no means proves that fracture or luxation has not occurred. Indeed, my tables of spinal injuries show that deformity has only been noted in about one-fourth of the whole number of cases, and it is easy to understand, in view of the deep-seated position of the vertebral column, that fatal displacement might occur, which yet might not be revealed except by careful post-mortem dissection.

Fig. 169.



Bilateral forward dislocation of the fifth cervical vertebra. (Ayres.)

(2.) *Undue Mobitity* has been occasionally observed in cases of vertebral injury, chiefly in the cervical region, and, on the other hand, *Immobility* has been noted in about the same number of instances. I do not know that either of these symptoms can be relied upon to distinguish the injury, in any given case, from simple sprain of the vertebral column, and the surgeon should exercise great caution in his tactile investigations upon this point, as very slight force, or even an unwary movement, might induce displacement, which in the cervical region might probably cause instant death.

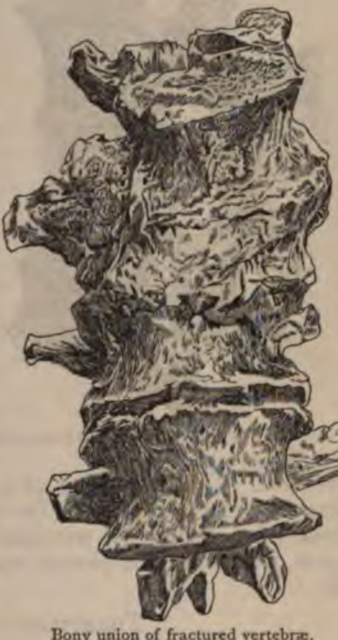
(3.) *Crepitus*, if present, would of course warrant the diagnosis of fracture, though it could not indicate in what part of the vertebra the lesion existed. Statistics show, however, that crepitus has been observed in about two per cent. only of recorded cases.

Diagnosis.—From what has been said, it will be perceived that, as already observed, the differential diagnosis of spinal injuries is always difficult, and often impossible. This is, however, fortunately a matter of no practical moment, for, as we shall presently see, the treatment is essentially the same, whatever may be in any case the exact nature of the injury.

Prognosis.—The prognosis of fracture or luxation of the vertebræ, while always grave, is not by any means so gloomy as is ordinarily represented. Sir Astley Cooper, and more lately Prof. Brown-Séquard, have surmised that the proportion of recoveries in these cases is less than one per cent., while Mr. Erichsen goes so far as to declare that "fractures of the spine through the bodies of the vertebræ, with displacement, are inevitably fatal." The opinion of these authors is not, however, borne out by the results of statistical investigation, which show that the mortality of terminated cases met with in *civil practice* varies from 78 per cent. in injuries of the cervical region to so low a figure as 61 per cent. in those of the lumbar spine, the corresponding proportions of recoveries being 18 per cent. in the former, and 27 per cent. in the latter region. The chances of a fatal issue in these cases vary inversely with the distance of the point of injury from the brain. Lesions above the third cervical vertebra prove usually immediately, or very quickly, fatal, though instances of long survival, or even of complete recovery, after fractures of the atlas or axis, have been recorded by Phillips, the elder Cline, Willard Parker, W. Bayard, Stephen Smith, C. S. May, and several other surgeons.

The prognosis in cases of *gunshot injury* of the vertebræ is, also, less unfavorable than has been commonly supposed. Many such cases no doubt prove fatal upon the field of battle, but of 642 tabulated by Dr. Otis, as having been treated during our late war, only 349 terminated in death, while 279 ended in more or less perfect recovery.

Fig. 170.



Bony union of fractured vertebræ.

Duration of Life in Fatal Cases.—With regard to this point, it may be said, in general terms, that of cases of fatal injury in the cervical region, two-thirds die during the first week; in the dorsal region, two-thirds during the first month; and in the lumbar region, about the same proportion during the first year.

Condition after Recovery.—*Bony union* is, according to Rokitansky, rarely met with after fracture of the vertebræ, though instances of its occurrence have been recorded by Cloquet, Aston Key, and others. The accompanying cuts (Figs. 170, 171, 172), from photographs given me by Dr. Richard A. Cleemann, of this city, illustrate very beautifully the occurrence of osseous union after spinal fracture. The specimen, which was derived from the body of a patient whom I saw in consultation with Dr. Cleemann, is one of very great interest, showing, in addition to a fracture of the lumbar vertebræ, unilateral dislocation, which is a rare lesion in this region of the spine. The case illustrates the difficulty of diagnosis in these injuries, for careful examination during life revealed merely prominence of one vertebral spine, with a corresponding depression below it—thus indicating fracture of a vertebral body, but giving no reason to suspect the existence of luxation.

With regard to the *general condition* of patients, after recovery from injuries of the vertebral column, the prognosis will, of course, depend chiefly upon the nature and extent of the lesion to the spinal cord. If any portion of the cord be *completely divided or disorganized*, the parts of the body which derive their nervous supply from below the seat of the injury will necessarily be permanently paralyzed. Prof. Eve has collected seven cases, in which the cord was found by post-mortem inspection to be for a greater or less space entirely deficient, and in which life was yet prolonged for periods varying from a few days to twenty-two years;[1] and the only instance of these in which paralysis was not constant from the time of the injury, was Mr. Shaw's case, in which the cord appears at first to have been comparatively slightly injured, its want of continuity, as found at the autopsy, having been due to subsequent disorganization, which produced a return of paraplegia before death. The only case with which I am acquainted, in which *complete recovery* is supposed to have followed *complete division* of the cord, is one reported by Dr. Eli Hurd, of New York, in which, however, the diagnosis was not confirmed by post-mortem inspection.

When the injury to the cord is less severe, the prognosis is of course more favorable. The proportion of recoveries, with restoration to a useful and comparatively active life, is, for injuries of the dorsal and lumbar regions, about 23 per cent. of terminated cases, but in injuries of the cervical region, if instances of partial luxation be excluded, the proportion is much less.

Fig. 171.

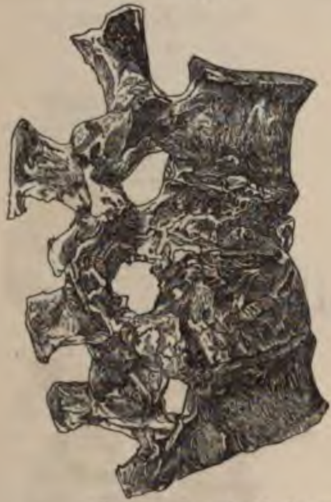
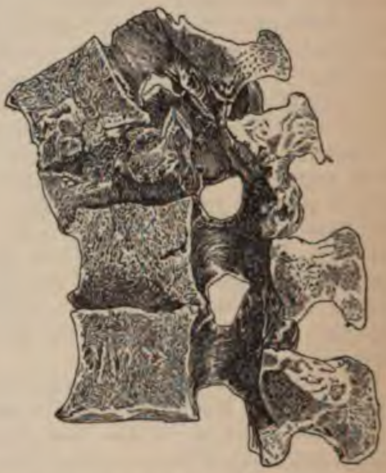


Fig. 172.



Fracture of vertebral body, and unilateral dislocation of a lumbar vertebra.

Treatment of Spinal Injuries.

The treatment of injuries of the spine involves attention to the state of both the vertebral column and the spinal cord.

Treatment as regards Vertebral Column.—If in any case there be evident vertebral displacement, or marked deformity, with paralysis, so that the surgeon has reason to believe that he has to deal with a spinal luxation, whether complicated or not with fracture, he should at once proceed to attempt *reduction* by means of *extension and counter-extension*, aided by cautious *manipulation*, *rotation*, and *pressure*. I am aware that this advice will be looked upon by many as injudicious; but statistical investigation shows that while there is but one case recorded (Petit-Radel's), in which efforts at reduction were the cause of death, there are many perfectly authentic instances, in which such efforts have been followed by the most gratifying success; and we should no more be deterred from attempting reduction, by the fatal result in one case of vertebral luxation, than we are from attempting to reduce dislocations of the shoulder or hip, by the fact that death has occasionally followed such attempts, in the hands of the most skilful surgeons. The mortality after spinal dislocation has been about four times as great when reduction has not been attempted, as when this treatment has been employed.

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[1] Am. Journ. of Med. Sciences, July, 1868, pp. 103–112.

If manual extension and counter-extension should fail to remove the deformity, in a case of injured spine, it would, I think, be right to apply *permanent extension* (to both legs), by means of the ordinary weight apparatus; the surgeon should, however, in such a case take great care, lest, from the pressure of the adhesive plaster or bandages, excoriations or sloughing should occur, and seriously complicate the patient's condition. I have not had occasion to employ splints in cases of fractured spine, but have adopted, with advantage, Hodgen's suggestion to give support by means of a plaster-of-Paris jacket, a mode of treatment which has also been adopted by König, of Gottingen, and by Coskery, of Baltimore.

Treatment as regards Spinal Cord.—In every case of spinal injury, the patient should be placed in bed, and kept at complete rest, both physical and physiological: a water-bed, if it can be obtained, or down pillows, will be found of great use in preventing the formation of bed-sores. If the vertebral column itself be not affected, the *prone* position, as advised by Erichsen, will probably be found the best, as facilitating the application of local remedies to the spine. In cases of fracture, however, the *supine* position is preferable, and the patient should not be incautiously turned upon his side, lest sudden displacement should occur, which might prove fatal. The patient should be kept scrupulously clean, and parts exposed to pressure should be frequently bathed with astringent or slightly stimulating washes. The bowels should be emptied from time to time by the use of enemata. It is usually recommended to draw off the urine at stated intervals, by means of a flexible catheter, and such has always been my own practice. It has, however, recently been recommended by Mr. Hutchinson, to dispense with the catheter, except in the rare cases of spinal injury in which retention is painful, allowing the bladder to become distended, and then trusting to the mechanical overflow to prevent injurious consequences. Fatal ulceration of the bladder has undoubtedly been occasionally traced to the use of the catheter, which in any case must aggravate the cystitis produced by distension and the ammoniacal state of the urine; and hence, though not prepared to go quite as far as Mr. Hutchinson. I would urge the importance of great gentleness in catheterization, which should only be done with a *flexible* instrument, used *without the stillette.*

If bed-sores form, they should be carefully and frequently dressed, with as little disturbance as possible to the patient. The alternate application of ice and hot poultices, has been highly recommended by Prof. Brown-Séquard.

Topical remedies are not of much value in the early stages of spinal injuries, though, if there were much tenderness and local pain, ice-bags might perhaps be used with advantage; at a later period, various forms of counter-irritation may be employed, with a view to a derivative action on the spinal cord and membranes.

Constitutional Treatment.—The general treatment during the *early stages*, should be such only as is indicated by the constitutional condition of the patient. Opium may be given at any period, to relieve pain or nervous irritation. Dr. McDonnell highly recommends the administration of belladonna as a sedative to the spinal cord, and advises that it should be combined with opium, whenever the latter remedy is prescribed in these cases. On the onset of *inflammatory symptoms*, small doses of calomel, or of the corrosive chloride of mercury, may be employed, or the iodide or bromide of potassium. Ergot has proved useful, in the hands of Prof. Hammond, in cases of myelitis following spinal injury. After the subsidence of inflammation, strychnia has often proved of the greatest benefit; at the same time, electricity, systematically applied to the paralyzed parts, with friction, and cold or warm douches to the spine, may often be serviceable. Tonics, especially iron, quinia, and cod-liver oil, which may be required at an early period, are peculiarly indicated in the latter stages of spinal injuries. The diet throughout should be nutritious but unirritating, with or without stimulus according to the circumstances of each individual case.

Trephining or Resection in Injuries of the Spine.—This operation has been suggested and described by surgical writers for a very long period, its history reaching back, indeed, to the days of Paulus Ægineta. The first surgeon, however, who actually practised the operation on the living subject, was the elder Cline,[1] in the early part of the present century, and his example has been followed by other surgeons from time to time, the whole number of cases now on record amounting to over forty. The object, of course, is to remove the vertebral arches at the seat of injury, and thus, if possible, relieve the cord from pressure, which is supposed by the advocates of the operation to be the cause of paralysis in these cases. But, as a matter of fact, post-mortem inspection has shown that compression exists in but a small number—less than one-third—of fatal cases, and that even in these instances the cord is usually so much lacerated or disorganized as to preclude any benefit from operative interference; moreover, compression, when it does exist, is almost always due to the pressure exercised by the *body* of the vertebra, so that all that resection could possibly do would be, as Dr. McDonnell, has phrased it, to take away the "counter-pressure."

The operation is by no means an easy one,[2] and is in itself attended with no small danger to the patient; beside the inevitable risks which must follow the conversion of the injury into a compound fracture, the exposure of the delicate structures within the vertebral canal, and the permanent loss of firmness and strength in the spinal column, consequent on the removal of one or more of the vertebral arches, the operation entails immediate peril upon the patient, death having occurred in one case (Willett's) before the operation could be completed. Finally, the statistics of the operation show beyond question that, far from increasing, it positively diminishes the chances of recovery. The following table embraces a record of 41 cases, being, as far as I can ascertain, all in which the operation of spinal resection for fracture[3] has been hitherto performed.

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[1] Louis's operation, in 1762, often referred to as an instance of spinal resection, consisted merely in the removal of detached fragments in a case of gunshot injury; a perfectly legitimate and conservative procedure, which was resorted to twenty-four times during our late war, with fourteen recoveries.

[2] "I am satisfied," says Prof. Eve, "that this operation, in the dorsal vertebræ, if not almost impracticable, is certainly one of the most difficult in surgery" (*Am. Journ. Med. Sciences*, July, 1868, p. 106).

[3] Resection of the spine for *disease* has been performed by various surgeons, includ-

Cases of Resection of the Spine.

No.	Result.	Operator's name.	Reference.
1	Died.	Cline, Sr.	Chelius's Surgery; ed. by South, i. 590.
2	"	Wickham.	Lancet, 1827.
3	"	Oldknow.	Hutchison, in Am. Med. Times, 1861.
4	"	Tyrrell.	Malgaigne, Fractures et Luxations, i. 425.
5	"	Id.	Ibid.
6	"	Barton.	Malgaigne (Packard's translation), p. 343.
7	"	Boyer.	Heyfelder, Traité des Résections (trad. par Boeckel), p. 244.
8	"	D. L. Rogers.	Am. Journ. of Med. Sciences, o. s., vol. xvi.
9	"	Attenburrow.	Chelius and Heyfelder, op. cit.
10	"	Laugier.	Malgaigne, op. cit.
11	"	Holscher.	Brown-Séquard, Central Nervous System, p. 256.
12	Relieved.	A. G. Smith.	N. A. Med. and Surg. Journ., vol. viii, p. 94.
13	Died.	Mayer.	Heyfelder, op. cit.
14	"	South.	Notes to Chelius, vol. i., p. 591, etc.
15	"	Blackman	Hutchison, loc. cit.
16	......	Edwards.	Brit. and For. Med. Review, 1838.
17	......	Blair.	Ballingall, apud Hutchison, loc. cit.
18	......	Goldsmith.	Gross's Surgery, 2d edit., vol. i.
19	Died.	Stephen Smith.	Hutchison, loc. cit.
20	"	Hutchison.	Ibid.
21	"	G. M. Jones.	Brown-Séquard, op. cit., p. 255.
22	"	H. A. Potter.	Hurd, N. Y. Journ. of Med., 1845.
23	"	Id.	Am. Journ. of Med. Sciences, n. s., vol. xlv.
24	Not improved.	Id.	Ibid.
25	Died.	R. McDonnell.	Ibid., vol. l.
26	Relieved.	Sam'l Gordon.	Med.-Chir. Trans., vol. xlix., p. 21.
27	Died.	Tillaux.	Brit. and For. Med.-Chir. Review, 1866.
28	"	Willett.	Med. Times and Gazette, Feb. 2, 1867, and St. Barth. Hosp. Rep., vol. ii., p. 242.
29	......	H. J. Tyrrell.	Dub. Quart. Journ. of Med. Sci., Aug., 1866.
30	Died.	Maunder.	Med. Times and Gazette, Feb. 23, 1867.
31	Not improved.	Eve.	Am. Journ. of Med. Sciences, n. s., vol. lvi.
32	Died.	Cheever.	Boston City Hosp. Reports, 1870, p. 577.
33	"	Id	Ibid., p. 580.
34	"	......	St. Bartholomew's Hosp. Reports, vol. vi.
35	"	Nunneley.	Med. Times and Gazette, Aug. 7, 1869.
36	"	Id.	Ibid.
37	"	Id.	Ibid.
38	Relieved.	Id.	Ibid.
39	Died.	Willard.	Am. Journ. of Med. Sciences, n. s., vol. lxiii.
40	......	Stemen.	Clark, Clinic, June 5, apud Monthly Abstract of Med. Science, August, 1875.
41	Not improved.	Lucke.	Revue des Sciences Médicales, Avril, 1880.

In 36 of the above 41 cases the result is known: 30 patients died; 3 were relieved, and 3 received no benefit from the operation. The most successful cases which the advocates of spinal resection have yet been able to produce, are those of Dr. Gordon and of Mr. Nunneley; in the first, more than a year after the operation, the patient was "unable to stand or walk," while in the second, the patient, during the two and a half years which he survived, was, though strong in the arms, "weak and partially paralyzed

ing Heine, Roux, Holscher, Dupuytren, and Jacobi, of New York. Dr. Blackman is reported to have operated more than once, but I can find no record of his other cases. He excised a portion of the *sacrum*, upon one occasion, but without benefiting his patient. Dr. J. B. Walker, of Boston, excised a spinous process.

in the legs." Considering, therefore, the not infrequent favorable issue of these cases under expectant treatment, and in view of the fact that the mortality after the operation has been over 83 per cent. of terminated cases, and that *no well-authenticated instance of complete recovery* after its employment, has yet been recorded; surely we are justified in declaring with Le Gros Clark, that we "cannot regard trephining the spine as brought within the pale of the justifiable operations in surgery."

I would respectfully invite the reader, who is interested in the further investigation of the subject, to consult the elaborate statistical tables, embraced in my monograph on Injuries of the Spine, already referred to.

If the operation of spinal resection is to be done at all, it can, probably, be best accomplished, as recommended by Dr. McDonnell, by making a free and deep incision, and then dividing the bony laminæ, on either side of the spinous process of the injured vertebra, with strong cutting forceps bent at an angle—an instrument which would prove more serviceable, in this position, than either a trephine, or a Hey's saw; a single arch having been removed, any additional portions of bone may be readily taken away with the ordinary gouge forceps.[1] Dr. McDonnell recommends very highly the internal administration of belladonna, or atropia, during the after-treatment of these cases, in order to prevent the development of inflammation of the membranes or spinal cord.

CHAPTER XVII.

INJURIES OF THE FACE AND NECK.

Injuries of the Face.

Wounds of the Face present no peculiarities requiring different treatment from that of similar injuries in other parts. The tissues of the face are so vascular, that primary union is usually attainable, at least in the case of incised wounds. As it is desirable to avoid any disfigurement, in a part which is constantly exposed to observation, I think it best to dispense with sutures, in the treatment of superficial wounds of the face, approximating the parts as accurately as possible by means of the gauze and collodion dressing. In certain localities, however, as in the *eyelids* or *eyebrows*, *nose*, *ears*, and *lips*, the employment of sutures is usually indispensable: in penetrating wounds of the cheeks, also, stitches, embracing almost the entire thickness of the parts, should be applied. *Harelip pins*, which may always be used with advantage in wounds of the lips, may be employed in any of these cases to control arterial bleeding, the pin being passed under the vessel, which is then compressed above it by means of the twisted suture. No matter how much contused and lacerated any part of the skin of the face may be, it should not be removed, but should be replaced, after having been carefully cleansed, in hope that reunion may occur. The deformity which sometimes results from such an injury, may often be remedied by a plastic operation—which may also be required in cases of deformity from burn, in which mechanical extension has failed to procure relief (see p. 307).

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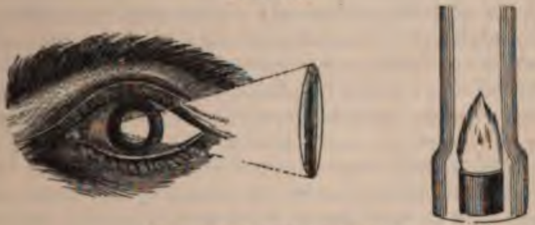
[1] See Dr. McDonnell's paper in the *Dublin Quarterly Journal of Medical Sciences*, for August, 1866, pp. 31–33.

Orbit and Eyeball.—Injuries of the *Orbit* may prove fatal through implication of the brain, either primarily, or, at a later period, by the extension of inflammation. Pointed instruments, such as a sword, a stick, or the end of an umbrella, may be thrust through the orbital plate of the frontal bone directly into the brain. In a case recorded by Dr. Wm. Pepper, a knife was thrust through the sphenoidal fissure, wounding a large meningeal vein, and causing death from intra-cranial hemorrhage. In other instances, again, wounds of the orbit have been followed by the formation of arterio-venous aneurisms, as in a case of Nélaton's, in which the point of an umbrella wounded the cavernous sinus and internal carotid artery of the opposite side—death ultimately resulting from the bursting of the aneurismal tumor. Deep-seated suppuration may occur as the result of orbital injury, the abscess pointing in either eyelid, or proving fatal by extending backwards to the brain.

FIG. 173.

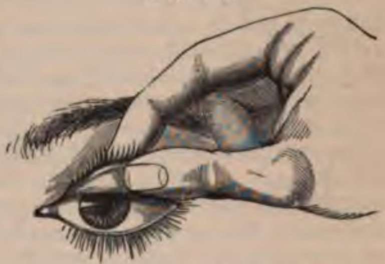


Oblique illumination. (WELLS.)

Wounds of the orbit may cause *blindness,* without directly involving the eyeballs, either by injury to the optic nerves, or, possibly, by inducing a reflex condition, depending upon lesion of other neighboring nerves, as of branches of the fifth pair.[1] In a case reported by Dr. Packard, immediate and total blindness followed a gunshot wound of both orbits, the patient surviving the injury for four years and a half, and eventually dying from other causes.

Foreign Bodies lodging on the eye may be embedded in the cornea, or may be concealed between the ball and either eyelid. From the cornea, the offending particle may be removed without much difficulty, simply by picking or gently prying it off with an ordinary cataract needle; if, in doing this, the cornea be superficially abraded, it is well, before dismissing the patient, to apply a drop of castor oil, which will effectually protect the surface until the slight breach of continuity has been repaired. A foreign body on the cornea can usually be readily detected by carefully examining the part in a bright light; in any case of doubt, however, *oblique illumination* should be employed (Fig. 173), a second convex lens being used, if necessary, as a magnifier. The conjunctival fold of the lower eyelid may be explored by simply drawing down the lid, and directing the patient to look upwards; to explore the fold of the upper lid

FIG. 174.



Eversion of upper lid for detection of foreign bodies. (ERICHSEN.)

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[1] The possibility of such an occurrence is doubted by Holmes Coote, and other surgeons, who attribute the amaurosis in these cases to a "concussion of the retina," rather than to the effect of sympathy.

it is necessary to *evert* the eyelid, which may be done either with the forefinger and thumb (Fig. 174), or with a probe, or the end of a pencil or quill, laid transversely across the lid. This little operation, which is more difficult than it appears, is done by firmly but lightly seizing the edge of the lid between the thumb and forefinger (the patient looking downwards, and the lid being drawn well down, and slightly away from the ball), and then by a quick movement turning up the edge of the lid over the point of the finger, which is simultaneously depressed. If the probe be employed, the central eyelashes, or the edge of the lid, must be taken between the thumb and finger of one hand, while the probe is manipulated with the other. The eyelid being everted, its edge is pressed against the edge of the orbit, when almost the whole conjunctival fold comes into view. The foreign body may then be removed with delicate forceps, the smooth end of a probe, or a moistened camel's-hair brush; it is sometimes possible to feel the foreign body with the tip of the finger, when, from its transparency, it cannot be seen. In some cases, in which the offending object has eluded both touch and vision, I have succeeded in dislodging it by sweeping out the fold of the eyelid with a camel's-hair brush; and in one instance, after I had failed to detect the foreign body by everting the lid, I succeeded by placing the patient in a bright light, with his head thrown very far backwards, when, by simply drawing the lid away from the ball, I was enabled to see almost up to the sulcus.

Contusion of the Eyeball may cause temporary blindness by inducing a condition of the retina analogous to concussion of the brain; in other cases, the loss of sight may be permanent, from detachment of the retina, hemorrhage, or inflammatory changes. The ordinary "black eye" of pugilists consists in an extravasation of blood beneath the conjunctiva, and into the loose areolar tissue of the eyelids. In this situation absorption is often very slow, the subconjunctival stain sometimes persisting for several weeks; the best application is cold water, or a mild alcoholic lotion. Contusion of the eyeball is sometimes accompanied by rupture of the cornea or sclerotic, allowing the escape of the humerus of the eye, and causing permanent loss of vision; in other cases the rupture may be internal, extravasation occurring, and filling the anterior chamber of the eye with blood, the iris being sometimes torn from its ciliary attachment, or the lens dislocated from its position. The treatment consists in the frequent instillation of a solution of atropia, gr. ij–iv to f℥j, and in the administration of calomel and opium, while the patient is kept in bed, in a darkened room, and upon milk diet. After the absorption of the effused blood, which is usually soon effected, vision may be restored, though it is often rendered imperfect by bands of lymph crossing the anterior chamber and the pupil. A dislocated lens usually becomes cataractous, and often causes intense pain and frequent attacks of iritis, by pressing upon the ciliary bodies and iris; in either case, extraction should be promptly resorted to. From the anterior chamber, the lens may be removed by simple corneal section, and from the posterior chamber, by a similar operation, a preliminary iridectomy having been first performed. If suppurative disorganization of an eyeball occur, excision may be necessary to prevent the other eye from becoming sympathetically involved.

Non-penetrating Wounds of the Eyeball are not usually of a serious nature. The treatment consists in the removal of foreign bodies, followed by the application of a drop or two of castor oil, with the use of cold compresses if the injury be attended with much pain. *Penetrating Wounds* are attended with much greater risk, the chief dangers being from prolapse of the iris, escape of vitreous humor, and, at a later period, from inflammation. If the iris protrude, an effort should be made to replace it by means of a fine probe; if this be impossible, the projecting portion should be snipped off with curved scissors, and if a staphyloma be subsequently formed, an iridectomy should be done opposite the most transparent part of the cornea; this operation is, according to Soelberg Wells, much preferable to the old mode of treatment, by the repeated application of nitrate of silver. Incised wounds of the sclerotic, if not very large, may be brought together with one or two fine sutures, any protruding portion of iris or vitreous humor being first cut away. In cases of extensive wound, with escape of a large portion of the contents of the eye, excision should, as a rule, be immediately performed, especially in patients of the poorer class, to whom the time required for treatment is a matter of importance. If an attempt be made to save the ball, cold compresses should be applied, atropia being very freely used, and calomel and opium administered internally. It may be necessary at a later stage to make an artificial pupil, to extract the lens (if this have become the seat of traumatic cataract), or to perform excision, if vision be lost and suppurative disorganization of the eyeball have occurred, particularly if sympathetic implication of the other eye be threatened. The lodgment of a foreign body in the deeper parts of the eye usually requires excision of the globe, though it may occasionally be possible to remove the offending substance while preserving useful vision. Dr. McKeown, of Ulster, has recorded several cases in which fragments of steel were removed by the aid of a pointed magnet introduced through the wound, and recommends the use of a large magnet, moved about externally to the eye, as a means of diagnosis. Magnets have also been successfully employed in cases recorded by McHardy, Hirschberg, Snell, Appleyard, Galezowski, Oppenheimer, Owen, Reid, and Jeffries. A convenient instrument for the purpose has been devised by Gruening, of New York.

Nose.—Foreign bodies, such as beads, peas, bits of sponge, etc., are often introduced by children into the nostrils, where they occasionally become firmly fixed, and, if allowed to remain, cause a troublesome form of ozæna. The foreign body may usually be removed without much difficulty, by means of delicate forceps, a bent probe, or a small scoop (such as is often placed at one end of a grooved director), or by means of Thudichum's douche, the current being of course directed through the opposite nostril. Politzer's air-bag is used for the same purpose by J. O. Tansley, of New York.

Ear.—Foreign bodies may be removed from the external ear with forceps, scoop, wire loop (as advised by Hutchinson), or, which is certainly the safest means, by long-continued, and, if necessary, repeated syringing with tepid water, the pinna being drawn *upwards*, or, in the case of very young infants, *downwards*, so as to straighten the auditory canal. Prof. Gross uses a steel instrument, spoon-shaped at one end, and provided at the other with a delicate tooth, placed at a right angle. This instrument is doubtless very efficient and safe in skilful hands, but the general practitioner will, I think, do wisely to be satisfied with simple syringing, which is indeed, according to Dr. Roosa, and to Gruber, of Vienna, much preferable to any other means of treatment. An ordinary hard rubber syringe of the capacity of three or four ounces may be used, the returning water being received in a bowl held beneath the ear. When there is much inflammation, Gruber advises that attempts at removal should be postponed until the subsidence of acute symptoms, when the auditory passage may be dilated with sponge tents, and shrinking of the foreign body promoted by the use of astringent solutions. Guersant prefers to ordinary syringing, *irrigation*, which may be conveniently effected with a Thudichum's douche, or by means of the double hand-ball syringe used for the administration of enemata. Should syringing fail, or should a perforation of the membrana tympani render its employment unadvisable, Löwenberg's *agglutinative method* may be properly tried; this, which is a revival of the plan long since taught by Paulus Ægineta, consists in the introduction of a delicate pencil, tipped with glue or plaster of Paris, which is allowed to remain in contact with the foreign body until adhesion takes place, when both may be withdrawn together.

Cheek.—Wounds of the cheek occasionally result in the formation of troublesome fistulæ. If small, a cure may be effected by pressure and the application of nitrate of silver, a red hot wire, or the electric cautery; if larger, the edges of the fistula should be pared, and closely approximated with sutures and a compress. If the wound involve the parotid duct, its opening into the mouth may be obliterated, and a true *Salivary Fistula* result. The treatment consists in establishing an artificial inner opening by H. Morris's plan of introducing a fine catgut or whalebone bougie from the mouth into the affected duct; by forming a seton, by means of a small trocar and canula passed in the natural direction of the duct, the external opening being subsequently closed; by turning the fistulous orifice, with or without the surrounding integument, into the mouth, as practised by Van Buren, Langenbeck, J. R. Wood, and E. Mason; or by the ingenious operation of the late Prof. Horner, which consists in cutting out the diseased tissues with a large and sharp saddler's punch, pressed firmly against a wooden spatula previously introduced into the mouth, the external wound being then immediately closed with the twisted suture. J. Allan reports two cures by the application of belladonna and glycerine over the parotid gland, so as to arrest the secretion, and thus permit the healing of the wound.

Mouth.—Wounds of the *Lips* should be treated by the application of harelip pins, with additional points of the interrupted suture, special care being taken to secure accurate adjustment of the prolabium. Additional firmness may be afforded by the use of broad adhesive strips, passing from side to side, or of Hainsby's cheek compressor, as after the operation for harelip. Wounds of the *Tongue* do not require sutures, unlesss a considerable portion of the organ be nearly detached. Hemorrhage may require the application of ligatures, or of the hot iron. Wounds of the *Soft Palate*, unless very small, require stitches, which may be applied as after the operation of staphyloraphy. Foreigh bodies, such as pistol-balls, teeth, or pieces of tobacco-pipe, may be lodged deeply in the tongue or pharynx, giving rise in the latter situation to suppuration, and sometimes to fatal secondary hemorrhage.

INJURIES OF THE NECK.

Wounds.—These injuries, which are usually of the character of *Incised Wounds*, are most commonly inflicted in attempts to commit suicide. It is occasionally a matter of some importance, in a medico-legal point of view, to be able to determine whether a given wound of the neck has been self-inflicted, or received at the hands of another; it is, of course, impossible to arrive at absolute certainty upon this point, but it may be said, in general terms, that suicidal wounds commonly begin on the left side of the neck (the person being right-handed), and pass transversely or obliquely downwards across the part, the extent of the wound on the right, being usually less than that on the left, side. They rarely penetrate so deeply as to divide the great vessels; hence the *primâ facie* probability with regard to a very deep wound, "penetrating as by a stab perpendicularly towards the spine," and perhaps involving the vertebral column, would be that it was not self-inflicted.[1] Wounds of the neck may be divided into—1. *Non-Penetrating Wounds,* which do not involve the air-passage or œsophagus; and 2, *Penetrating Wounds,* which do involve one or both of those important organs.

1. Non-Penetrating Wounds.—The danger of non-penetrating wounds of the neck, is chiefly from hemorrhage, which is often very profuse; if the carotid artery or internal jugular vein be wounded, death may be almost instantaneous, and even bleeding from comparatively small vessels may prove fatal in the depressed state, both physical and mental, which is usually present in patients who have attempted suicide. Another danger is from the entrance of air into the large veins in this region, which may cause sudden death, or, as in a case recorded by Le Gros Clark, may prove fatal at a later period, by the air becoming gradually mixed with the blood, and thus interfering with the heart's action. The pneumogastric or phrenic nerve may also be wounded in these cases, and either event would of itself almost certainly cause the death of the patient. The *treatment* of non-penetrating wounds of the neck, consists in arresting hemorrhage, and in approximating the edges of the cut, in such a way as to favor union. Every bleeding vessel, whether artery or vein, should be secured by ligatures above and below the opening in its coats, or to either extremity if it be completely divided. In cases of arterial bleeding, in which the precise source of hemorrhage cannot be detected, the surgeon should not hesitate, if necessary, to ligate the common carotid, an operation which, according to Pilz, has been done, in cases of punctured and incised wounds, in 44 instances with 20 recoveries, and, according to Cripps, in 51 instances with 23 recoveries (to which may be added a successful case in my own hands), the total number of cases in which the carotid has been tied for hemorrhage being, according to the first-named author, 228, with 94 recoveries. Whenever it is practicable, however, an effort should be made to substitute ligation of the *external* carotid, which Cripps has shown to be a much safer operation. Approximation of the lips of the wound is best effected by numerous points of the interrupted suture, the ligature threads being brought out at the angles of the wound, where they serve to secure drainage. The sutures should embrace the skin and superficial fascia only, and the deeper parts of the wound should be approximated by means of broad strips of adhesive plaster, brought obliquely around the neck. The parts should be further relaxed by bending the head forwards, with the chin almost touching the sternum, and by securing it in this position, by means of a nightcap, or sling, which should pass from the occiput to a circular band around the chest. Primary union, though always to be sought, is rarely attained in cases of cut-throat, the whole surface of the wound not unfrequently sloughing, and eventually healing by granulation.

2. Penetrating Wounds of the neck may involve any portion of the air-tube, though the larynx is the part usually affected. The relative frequency of these wounds, in different situations, may be seen from the following table of 158 cases, collected by Mr. Durham:—

Situation of wound.	Number of cases.
Above the hyoid bone	11
Through the thyro-hyoid membrane	45
Through the thyroid cartilage	35
Through the crico-thyroid membrane or cricoid cartilage	26
Into the trachea	41

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[1] See upon this point a paper by Dr. Taylor, in Guy's Hosp. Reports, 3d s., vol. xiv., pp. 112–144.

The special dangers of penetrating wounds of the neck, apart from such as are common to these injuries and to those which are non-penetrating, are the occurrence of *asphyxia*, or more correctly *apnœa*, *emphysema*, *dysphagia*, and, at a later period, *bronchitis* and *pneumonia*.

Difficulty of Breathing, ending, perhaps, in complete *Suffocation* or *Apnœa*, in wounds of the throat, may depend upon several causes. It may result directly from the accumulation of blood, either liquid or clotted, in the air-passages; from displacement of divided parts, as from a portion of the tongue, the epiglottis, or a fragment of cartilage, falling backwards and obstructing the rima glottidis; or, if the rings of the trachea be widely separated, from the external soft parts being sucked inwards, and producing valvular occlusion of the air-tube. Again, suffocation may result from œdema of the glottis, from submucous emphysema, or from the pressure of an abscess.

Emphysema is not usually a grave complication; it may, however, as already mentioned, produce suffocation, when seated beneath the laryngeal mucous membrane, or, according to Hilton, may prove directly fatal by pressure on the phrenic nerves.

Dysphagia, sometimes amounting to complete inability to swallow, is occasionally a source of great danger. Either from a wound of the œsophagus—or, without this part being involved, from insensibility of the glottis—saliva, and even particles of food, may escape into the air-tube, and make their appearance at the external wound.

Bronchitis and *Pneumonia* may arise from the irritation produced by the presence of blood, pus, or food, in the air-passages, from the admission through the wound of cold and dry air to the lungs, or possibly from the direct extension of inflammation from the seat of injury.

Among the occasional *remote consequences* of penetrating wounds of the throat may be mentioned alteration or loss of voice, and the formation of a traumatic stricture of the trachea or gullet, or of an aerial or œsophageal fistula.

Treatment.—After the arrest of hemorrhage, as in cases of non-penetrating wound, the surgeon may apply a few sutures to either extremity of the incision, leaving, however, the central portion, *as a general rule*, to heal by granulation; an exception should be made in those cases in which the air-tube is completely cut across, when, to prevent wide separation, it may be necessary to apply a stitch on either side, so as to hold the parts in apposition. The sutures, which in such a case should be of fine thread, may be passed through the superincumbent connective tissue, or even superficially through the cartilages themselves, one end being cut off, and the other brought like a ligature through the external wound. In other cases, from the persistence of venous oozing, or from the occurrence of dyspnœa on attempting to close the wound, it may be necessary to introduce, for a time at least, a tracheal tube, as after the operation of tracheotomy. If, at any time, apnœa be threatened, the wound should be instantly reopened, and, if necessary, artificial respiration resorted to. Tracheal or laryngeal *stricture* may, at a later period, require the performance of tracheotomy, followed by systematic dilatation or even external division, as in a case recorded by Trendelenburg, or by excision of portions of the tracheal rings, or cricoid cartilage, as practised by H. Lee, of London, and by myself, in a case under my care at the University Hospital; aerial *fistula* may (provided the larynx be unobstructed) be closed by a plastic operation.

INJURIES OF THE LARYNX AND TRACHEA.

A blow upon the larynx may prove fatal through shock, or by inducing spasm of the glottis; when the injury is less severe, temporary insensibility only may result. The treatment, in slight cases, consists in the adoption of such measures as may prevent subsequent inflammation, but if breathing have stopped, laryngotomy should be performed, and artificial respiration at once resorted to.

Fracture of the Larynx is an exceedingly dangerous accident, the mortality, according to Durham's statistics, being over 80 per cent. No age is exempt, though the injury usually occurs among young adults; five of fifteen cases analyzed by Hunt were in children, and only one in a person over forty-five years of age. The usual *causes*, apart from gunshot wounds, are, according to the same writer, "falls against hard and projecting substances, blows, kicks, and pressure." The *symptoms* are local pain and tenderness; swelling of the neck, with an alteration of its form, consisting either of flattening or of undue prominence; mobility of the cartilages, and occasionally crepitus. There are besides, often, dyspnœa and lividity of face, with the ordinary evidences of collapse, emphysema, and expectoration of bloody mucus; the latter symptoms are considered by Hunt particularly unfavorable, as indicating laceration of the laryngeal mucous membrane. The annexed table, from Durham, gives a summary of 62 recorded cases, 52 collected by Hénoque, and 10 added by Durham himself. It will be observed that death followed in every case in which the cricoid cartilage[1] was involved.

Cartilages fractured.	No. of cases.	Deaths.	Recoveries.
Thyroid only, ...	24	18	6
Cricoid only, ...	11	11	...
Thyroid and os hyoides, ...	4	2	2
Thyroid and cricoid, ...	9	9	...
Thyroid, cricoid, and os hyoides, ...	2	2	...
Thyroid, cricoid, and trachea, ...	2	2	...
Cricoid and trachea,.	2	2	...
Cricoid, trachea, and os hyoides, ...	1	1	...
"Fractures of larynx,"	7	3	4
Total, ...	62	50	12

The *treatment*, in cases in which the displacement is slight, and in which there is no dyspnœa, may consist simply in supporting the parts with compresses and strips of adhesive plaster. If, however, the respiration be embarrassed, and particularly if there be bloody expectoration, no time should be lost in resorting to tracheotomy, which, under such circumstances, affords almost the only chance of saving the patient. Eight of the twelve cases of recovery were saved by operation, while in the remaining four, from the absence of hæmoptysis and emphysema, there is reason to believe, as remarked by Hunt, that the fractures were in the median line, and did not involve the mucous membrane. After the operation, an attempt may be made to restore the displaced parts to their proper position by manipulation. Panas and Caterinopoulos recommend, instead of tracheotomy, a section of the thyroid cartilage, followed by the introduction of a large tube, so as to keep the fragments in position. Dr. E. Holden, of Newark, N. J., has recently recorded a remarkable case of *dislocation of the inferior cornu of the thyroid cartilage.* Luxation of the *arytenoid* cartilage has been observed in two cases by Stoerk.

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[1] A remarkable case has been recently recorded by S Treulich, in which both thyroid and cricoid cartilages were broken—the latter in two places—and the trachea ruptured by the bite of a horse; life was saved by tracheotomy.

Fracture or Rupture of the Trachea, without injury of the larynx, and without external wound, is an extremely rare and usually fatal accident. Cases are reported by Lonsdale, Berger, Beck, J. L. Atlee, Jr., Robertson, Corley, Long, Drummond, and Wagner—those seen by the three last-mentioned surgeons being the only instances of recovery. In Long's case, life was saved by tracheotomy, supplemented by removal of blood from the air-passages by suction, and by artificial respiration. A case was under my care a few years since, at the Episcopal Hospital, in which an injury of the neck was followed by emphysema and passage of fluids from the œsophagus into the trachea, thus rendering probable the existence of a slight rupture of this organ; life was maintained for several weeks by means of nutritive enemata, and the patient eventually recovered. Dr. Lang, a German surgeon, has reported a remarkable case of *intussusception of the trachea,* which proved fatal at the end of ten weeks.

Burns and Scalds of the mouth, pharynx, and glottis are occasionally met with, especially among children, the most usual form of the injury resulting from an attempt to drink boiling water from the spout of a tea-kettle. It is probable that, in some cases, steam may reach the larynx itself, but in the majority of instances the air-passages become secondarily involved, by the extension of inflammation from the mouth and glottis. The dangers are those of submucous laryngitis and œdema glottidis, and the *treatment* consists in the application of leeches and ice to the throat, and in the administration of antimony, or of calomel and opium. Free mercurialization is considered by Bevan and Corley, of Dublin, to be the most important measure, and the latter surgeon reports a successful case in a child less than three years old, who in seventeen hours took twenty-four grains of calomel, and had six drachms of mercurial ointment rubbed into his groins and axillæ. The œdematous mucous membrane of the fauces and epiglottis may be scarified with a long needle, or with a curved bistoury, wrapped almost to its point with a strip of sticking plaster, and, if suffocation appear imminent, tracheotomy must be performed, as a last resort, though its results under these circumstances are far from satisfactory, 23 out of 28 cases collected by Mr. Durham having ended in death.

A similar injury may result from *drinking corrosive liquids,* such as the stronger mineral acids, or caustic alkalies. The *treatment* should be the same as in the case of scald of the glottis or larynx. Of three cases mentioned by Durham, in which tracheotomy was performed for such an injury, two died and one recovered.

Foreign Bodies in the Air-Passages.—A great variety of substances have been met with as foreign bodies in the air-passages, the most common being, according to Prof. Gross, grains of corn, beans, melon-seeds, pebbles, and cherry-stones. Several such objects, sometimes of a dissimilar character, have been occasionally met with in the same case. In four instances *leeches* have been extracted from the larynx, by Marcacci, Trolard, Massei, and

Clementi. Foreign bodies usually enter the air-passages through the glottis, being drawn in, in the act of inspiration, or simply dropping in, as in the case of coins tossed in the air and caught in the mouth, or—as has probably happened in some cases, in which suffocation having occurred during sleep or intoxication, the air-passages have been found to contain partially digested food—the foreign body may be regurgitated from the stomach, and may then make its way through the glottis, the sensibility of which is obtunded by the patient's condition. In other instances foreign bodies have entered the air-passages through accidental wounds or ulcerations of the œsophagus, of the tissues of the neck, or of the walls of the chest. Finally, in one case referred to by Prof. Gross, a lymphatic gland passed through an ulcer in one of the bronchi, and caused death by becoming impacted in the rima glottidis.

Situation.—A foreign body may be arrested in any portion of the air-passages, or, more rarely, may be movable, changing its position from time to time. The parts in which extraneous substances are most apt to become impacted are the larynx and one of the bronchi, usually the right.

Symptoms.—The primary symptoms, or those of *Obstruction*, are similar to those of inflammatory or spasmodic croup, only, if possible, more violent. The patient feels a sense of impending death, and is, indeed, for the time, in most imminent danger. The face becomes livid, the eyes apparently start from their sockets, the patient gasps and utters piercing cries, foams at the mouth, is perhaps convulsed, or falls insensible. The first paroxysm passing off, the symptoms of *Irritation* become prominent. There is a short, croupy cough, with pain, especially referred to the top of the sternum, and mucous or bloody expectoration. Paroxysms of dyspnœa, with a sense of suffocation, recur from time to time, and are due to the dislodgment of the foreign body, and to its being impelled against the larynx by the act of coughing. *Auscultation* will reveal various signs, according to the position of the foreign body; if this be loose in any part of the tube, it may be heard moving up and down with a flapping sound, and occasionally striking the wall of the trachea; if fixed in the larynx, there will be a harsh, rough sound in respiration, coinciding with croupy cough and the other symptoms of obstruction; if impacted in a bronchus, or one of its subdivisions, the respiratory murmur will be usually deficient, or quite absent, in the corresponding portion of the lung, and probably puerile on the opposite side, percussion giving an equally clear sound in both localities. Occasionally peculiar râles are due to the nature of the foreign body, as in a case referred to by Gross, in which an impacted plum-stone, perforated through its middle, gave rise to a strange whistling sound.

Diagnosis.—The diagnosis, though often very obscure, may, in most instances, be made by careful inquiry into the history of the case, and investigation of its symptoms. From *croup* the diagnosis can be made, as pointed out by Prof. Gross, by observing that in that affection the dyspnœa is most marked in inspiration, while expiration is most affected in obstruction from a foreign body. Aphonia is, according to the same author, the most trustworthy sign of impaction in the *larynx*, as distinguished from impaction in other portions of the air-tube. From *pharyngeal*, or *œsophageal obstruction*, the diagnosis is to be made by careful exploration with the finger and probang. In some cases, by means of the laryngoscope, the foreign body has been actually seen lodged in the larynx.

Prognosis.—As long as a foreign body remains in any portion of the air-passages, the patient is in imminent danger; the causes of death are suffocation (which may occur at any moment), hemorrhage, inflammation, ulceration, abscess, or simple exhaustion. The annexed summary, taken from

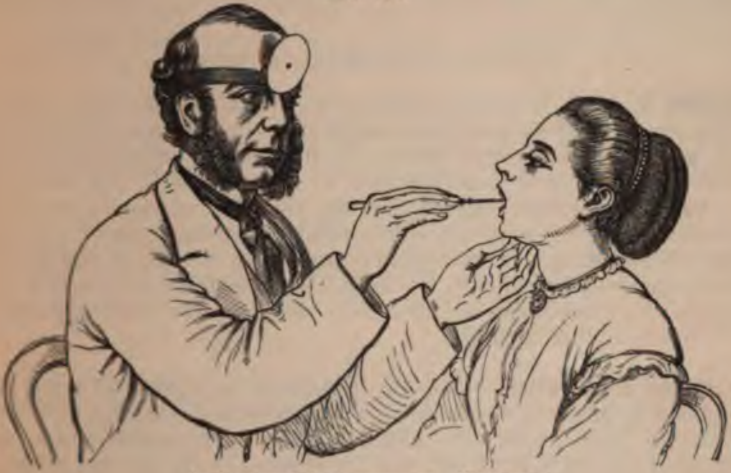
Mr. Durham's essay, shows compendiously the results in 554 cases—these being, I believe, the most comprehensive statistics which have yet been published.

1. *Cases in which no operation was performed:—* RESULT.	Total number of cases.	Re-coveries.	Deaths.
Death without expulsion of foreign body,	95	....	95
Spontaneous expulsion of foreign body,	164	149	15
Expulsion after emetics (recorded as useless in 46 cases)	5	5	....
Discharge at a late period through thoracic abscess,	7	2	5
Total of cases not operated on,	271	156	115
2. *Cases in which operative measures were adopted:—* OPERATION.			
Laryngotomy, followed by expulsion,	14	13	1
" not followed by expulsion,	3	....	3
Tracheotomy,	231	170	61
Laryngo-tracheotomy,	20	15	5
Direct extraction,	3	3	....
Inversion of body and succussion,	12	12	....
Total of cases operated upon,	283	213	70
Total number of cases operated upon or not,	554	369	185

The mortality therefore is, in general terms, as nearly as may be, 1 in 3, the death-rate *after operation* being less than 1 in 4 (24.8 per cent.), but *without operation* more than 2 in 5 (42.5 per cent.). The period during which a foreign body may remain in the air-passages, and yet be spontaneously expelled, varies from a few hours up to many years; in 64 of 124 cases of spontaneous expulsion with recovery, collected by Mr. Durham, this period was between one and twelve months.

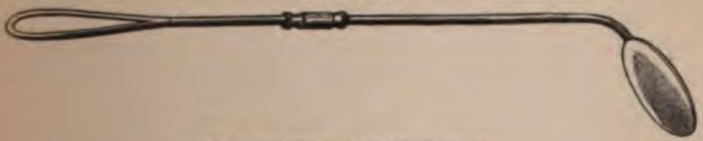
Treatment.—In a case in which the dyspnœa is not urgent, a careful *laryngoscopic examination* should be made, and, if the position of the foreign body be recognized, attempts may be made to remove it by direct extraction with suitable forceps; the same means may be employed after opening the trachea, and will then be more likely to succeed, as the risk of strangulation is removed. Voltolini proposes to search for the foreign body by introducing, through the tracheal wound, a *speculum* modelled after the ear speculum of Brunton. *Inversion and succussion*, which, though occasionally successful before tracheotomy, are under such circumstances both dangerous and painful, may, after the operation, be of much service in facilitating the escape of the offending substance. In the large majority of cases the surgeon should, as soon as he is satisfied as to the nature of the case, perform *tracheotomy*, or, if the symptoms be very urgent, *laryngotomy*, the latter operation being more quickly and more easily accomplished. If the foreign body be now found in the larynx, it should be dislodged and extracted, the surgeon, if necessary, dividing the thyroid cartilage in the median line (*thyrotomy*), or this and the cricoid as well (*crico-thyrotomy*). If the foreign body be in the trachea or bronchi, it may be immediately expelled through the tracheal wound, or more rarely through the mouth—though in other cases it may not be ejected until several hours or days, or even a much longer period after the operation. There is some difference of opinion, among surgeons, as to the propriety of endeavoring to extract foreign bodies through the tracheal wound, by means of forceps. Mr. Durham's statistics show, I think, conclusively, that such attempts are not only justifiable, but eminently proper, 41 cases, in which removal was effected by forceps, having given 39 recoveries, and but 2 deaths, neither of which appears to have been due to the use of the instrument. The best forceps for the purpose are those devised by Prof. Gross (Fig. 177), the blades of which are five inches long, and which, being made of German silver, can be bent to suit any particular case, while they are so delicate as not materially to interfere with the passage of air during the necessary manipulations.

Fig. 175.



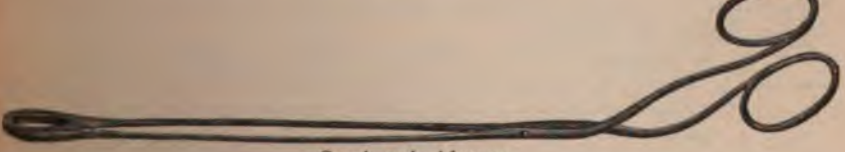
Application of the laryngoscope. (Erichsen.)

Fig. 176.



Throat-mirror used in laryngoscopy.

Fig. 177.



Gross's tracheal forceps.

After the exit of the foreign body, the wound may usually be closed at once; but, if there be much laryngeal irritation, a tube may be introduced for a few days, until this has subsided.

Subhyoidean pharyngotomy (see Chapter XXXVIII.) may, in some cases, be preferred to either laryngotomy or tracheotomy, and has been successfully resorted to in a case of foreign body impacted in the larynx, by Lefferts.

SURGICAL TREATMENT OF APNŒA.

Apnœa, or, as it is more commonly called, **Asphyxia,** may arise from various causes, such as drowning, inhalations of chloroform or of poisonous gases, spasm or œdema of the larynx, or the presence of false membrane, of a morbid growth, or of a foreign body in any portion of the air-passages. The surgical operations employed in the treatment of apnœa are, *artificial respiration* and the various procedures which are included under the general term of *bronchotomy.*[1] *Bronchotomy* is applicable to cases in which the air-passages themselves are in any way obstructed; *Artificial Respiration* to cases in which the air-passages are free, or in which apnœa continues after the performance of bronchotomy.

Artificial Respiration.—This may be effected in several ways:—

1. *Mouth to Mouth Inflation,* though objectionable as furnishing air which has already been expired, is occasionally the only method which can be employed in an emergency, and may be resorted to, in any case, while more efficient means are being procured.

2. *Inflation with Bellows,* provided with a suitable mouth or nose piece, may be efficiently used, provided that care be taken to secure expiration by manual compression, and that the instrument be worked gently, and not more than ten or twelve times in the minute.

3. *Inflation with Oxygen Gas* might be tried in extreme cases, or when other means had failed: the gas might conveniently be administered from a bladder, fitted with a mouth-piece.

4. Artificial respiration may readily be practised by alternately *Compressing the Chest and Abdomen with the Hands,* to imitate expiration, and then allowing the natural resiliency of the thoracic walls to produce expansion, and thus imitate inspiration. This method is very easily applied, and is particularly suitable in cases of apparent death from chloroform.

5. *Silvester's Method,* which is that adopted by the Royal Humane Society, of England, consists in placing the patient in a supine position, with the head and shoulders slightly elevated, then grasping the arms above the elbows, drawing them gently but steadily upwards till they meet above the head, keeping them thus for two seconds, and, finally, bringing them downwards, and pressing them for two seconds more against the sides of the chest. This manipulation is to be repeated, fifteen times in the minute, until natural respiration is established, or until a sufficient time has elapsed to show that further efforts are useless.

6. *Dr. B. Howard's "Direct Method,"* for cases of apparent death from drowning, consists in turning the patient downwards with a roll of clothing under the chest and abdomen, and making pressure on the back so as to force the water out of the lungs and stomach; then reversing the patient's position, putting the roll of clothing under the back, placing his hands together above his head, which is kept low, and practising artificial respiration

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[1] Macewen, Paton, and Sanctuary recommend catheterization of the larynx through the mouth, as preferable to bronchotomy in obstruction from causes other than the presence of a foreign body.

by compressing the lower part of the chest, and letting go with a jerk so as to allow the parts to expand by their natural resiliency.

7. *Marshall Hall's "Ready Method."*—This mode of treatment, which is, upon the whole, probably the best yet suggested, is thus described by its distinguished author, under the name of "Prone and Postural Respiration:"—

"(1.) Treat the patient instantly, on the spot, in the open air, exposing the face and chest in the breeze (except in severe weather).

"I. *To Clear the Throat.*

"(2.) Place the patient gently on the face, with one wrist under the forehead. [All fluids, and the tongue itself, then fall forwards, leaving the entrance into the windpipe *free.*] If there be breathing, wait and watch; if not, or if it fail—

"II. *To Excite Respiration.*

"(3.) Turn the patient well and *instantly* on his side, and

"(4.) Excite the nostrils with snuff, the throat with a feather, etc., and dash cold water on the face previously rubbed warm. If there be no success, lose not a moment, but instantly—

"III. *To Imitate Respiration.*

"(5.) Replace the patient on his face, raising and supporting the chest and abdomen well on a folded coat or other article of dress.

"(6.) Turn the body very gently on the side and a little beyond, and then briskly on the face, alternately; repeating these measures deliberately, efficiently, and perseveringly fifteen times in the minute, occasionally varying the side. [When the patient reposes on the chest, this cavity is compressed by the weight of the body, and expiration takes place; when he is turned on the side, this pressure is removed, and inspiration occurs.]

"(7.) When the *prone* position is resumed, make equable but efficient *pressure,* with brisk movement, along the back of the chest, removing it immediately before rotation on the side. [The first measure augments the expiration, the second commences inspiration.]

"The result is respiration; and, if not too late, life!

"IV. *To Induce Circulation and Warmth.*

"(8.) Rub the limbs *upwards,* with firm grasping pressure and with energy, using handkerchiefs, etc. [By this measure, the blood is propelled along the veins towards the heart.]

"(9.) Let the limbs be thus dried and warmed, and then clothed, the bystanders supplying coats, etc.

"(10.) *Avoid the continuous warm bath, and the position on or inclined to the back.*"

Whatever mode of treatment be adopted, should be perseveringly continued for three or four hours, unless sooner successful; if *secondary apnœa* come on after apparent recovery, artificial respiration should be again resorted to, together with the application of electricity to the base of the brain and upper part of the spinal cord.

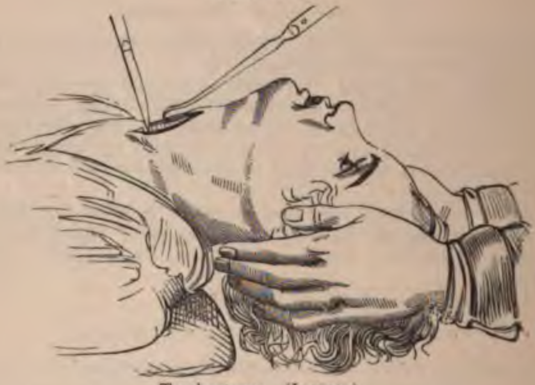
Bronchotomy.—Under this name are embraced the operations of *Laryngotomy* and *Tracheotomy,* together with their modifications, *Thyrotomy, Crico-thyrotomy,* and *Laryngo-tracheotomy,* the names of which sufficiently express their nature.

1. **Laryngotomy.**—In this operation the windpipe is opened through the crico-thyroid membrane. The larynx being steadied between the thumb and fingers of the left hand, the surgeon makes a longitudinal incision of about an inch, in the median line, over the lower half of the thyroid cartilage, the crico-thyroid space, and the cricoid cartilage. The sterno-hyoid muscles being now separated, and the intervening fascia and connective tissue divided to

the full extent of the cutaneous wound, the knife is at once thrust, with its edge upwards, through the crico-thyroid membrane and its mucous lining, into the larynx. The opening is then enlarged transversely as much as may be required, and the tube introduced. The only vessel likely to be cut is the crico-thyroid artery, which should, as a rule, be secured before opening the larynx. This operation, which is by no means difficult, may be performed either with or without the aid of anæsthesia, the patient being in a recumbent position, with the head thrown backwards, and the neck rendered prominent by means of a pillow beneath the nucha.

2. Tracheotomy.—In this operation two or more of the tracheal rings are divided, or an elliptical portion of their anterior face cut away. The patient being in the position already described, and preferably under the influence of an anæsthetic, the surgeon, standing at his left side, or, which I prefer, at his head, makes a longitudinal median incision, extending from the bottom of the cricoid cartilage to an inch and a half or more below, according to the length of the neck. The subcutaneous fat and areolar tissue are similarly divided, care being taken to avoid any superficial veins; the sterno-hyoid and sterno-thyroid muscles being then cautiously separated with the handle of the knife, or with the director, the trachea, crossed by the isthmus of the thyroid gland, is exposed. The trachea, which may be recognized by its *white* appearance, may be opened above, through, or below the thyroid isthmus, the first being, in the case of children especially, the point to be preferred; if it be necessary to cut through the isthmus, a ligature must be first applied on either side of the point of division. Hemorrhage having been arrested, the surgeon draws forwards the trachea with a tenaculum, and thrusting in his knife, edge upwards, divides the necessary number of rings. Any false membrane which presents itself having been gently withdrawn, the tube is introduced, and, when the respiration has become tranquil, the surgeon may, if it be thought proper, temporarily remove it, and proceed to cut away an elliptical portion of the front wall of the trachea; this step, though not, I think, in itself objectionable, is, however, seldom necessary.

FIG. 178.



Tracheotomy. (LISTON.)

The above description presupposes that the surgeon has time to make a careful dissection of the superincumbent parts, before opening the windpipe—and, in the immense majority of instances, enough time is afforded for this purpose. I believe, however, with Mr. Durham, that cases are occasionally met with in which it is very important to hasten the steps of the operation; and, in such an emergency, would recommend a plan described by that author, and which he assures us he has advantageously employed in nineteen instances. In this method the operator (standing on the patient's right side) places the forefinger of the left hand on the left side of the trachea, and the thumb on the right, pressing steadily backwards until he feels the pulsation of both carotid arteries. By slightly approximating the finger and thumb, he feels that the trachea is firmly and securely held between them, and knows that the safety of the great vessels is insured, while the tissues over the windpipe are rendered tense. The finger and thumb thus placed are not to be moved until the trachea is reached. By a succession of careful incisions, the surgeon now cuts boldly down on the windpipe, the finger and thumb on either side helping him to judge of the position of the median line (from which the knife must not deviate), and, by their pressure, causing the wound to gape, and the trachea to advance. The forefinger of the *right* hand is passed from time to time into the wound, to make sure that no important vessel is in the way, and when the trachea is reached the knife is introduced (guarded by the right forefinger), or the windpipe may be seized with a tenaculum and opened as in the ordinary operation.

The chief *danger* from tracheotomy is from *hemorrhage;* instances are on record in which the carotid, or even the innominate, artery[1] has been wounded, while fatal bleeding has not unfrequently occurred from the division of large veins. *Arterial* hemorrhage should, of course, be checked before opening the trachea, and bleeding *veins* should also be secured, provided that death from suffocation be not likely to occur while this is being done. It must be remembered, however, that the venous congestion is due, in great measure, to the obstruction of the patient's breathing, and will be lessened as soon as free respiration is established; hence the surgeon should not fear, if necessary, to open the windpipe even while venous bleeding continues, introducing the canula, as has been forcibly said, "even through a very pool of blood." In order to avoid the risk of hemorrhage, Verneuil, Bourdon, and Fowler, of Brooklyn, recommend the use of a knife heated by the galvanic cautery,[2] and report several cases in which tracheotomy has been thus bloodlessly performed. I cannot but doubt, however, whether this mode of treatment will ever supersede the ordinary operation with the simple scalpel.

Laryngo-tracheotomy is, as its name implies, a combination of laryngotomy with tracheotomy above the thyroid axis. Its mode of performance requires no special description.

After-treatment of Cases of Bronchotomy.—In almost all cases, except those of foreign body in the air-passages, it is necessary to introduce a *tracheal canula* or *tube*, which must be worn until the power of breathing through the larynx is restored. The tube should be made of silver, with a curve of rather less than a quarter of a circle, *double*, so that the inner canula may be removed and cleansed, while the outer retains its position, the two being secured by means of a button attached to the neck-plate of the outer one. The neck-plate itself should be so arranged as to allow the canula to move freely with the motions of the trachea, and the inner tube should project beyond the outer one for about a quarter of an inch, at either extremity. The canula should be from two to three inches in length, and, as advised by Mr. Howse and Mr. Parker, as large as can be conveniently introduced into the trachea. For use after *laryngotomy* the canula may be a little flattened, the transverse being somewhat greater than the antero-posterior diameter of its section.

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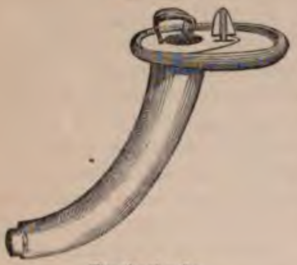
[1] *Secondary hemorrhage* from the innominate artery, resulting from ulceration due to pressure of the canula, proved fatal in two cases reported to the Anatomical Society of Paris, and referred to in the British Medical Journal for April 2, 1881. Hemorrhage from the tracheal mucous membrane proved fatal in one of my own cases, by giving rise to broncho-pneumonia.

[2] Amussat had previously employed the galvanic cautery, dividing the trachea from within outwards with a platinum wire previously introduced by means of a curved needle. Paquelin's thermo-cautery has been recently employed in tracheotomy by Poinsot, of Bordeaux.

Fig. 179.



Tracheal tube.

The canula above described, which embraces the improvements of both Obré and Roger, is, I think, preferable to either the ordinary double tube, or the bivalve canula of Fuller. Mr. Durham has suggested a still further modification, by which the length of the tube can be regulated, by means of a screw, to meet the emergencies of any particular case. Mr. Parker employs a tube, the shape of which he compares to that of a *Gothic* rather than a *Roman* arch. To facilitate the introduction of a tube, the edges of the wound may be held apart with two- or three-bladed dilating forceps, or, which is better, a blunt-pointed pilot trocar, as suggested by Dr. Gairdner, or a fenestrated tubular trocar, as employed by M. Péan, may be thrust in with the canula, to be withdrawn, of course, as soon as the latter is in place. Mr. Durham employs a "lobster-tailed" trocar, constructed on the same principle as Squire's "vertebrated" catheter. *Flexible* tubes are used by Mr. Morrant Baker.

The canula being introduced, is held in position by tapes, attached to the neck-plate, and fastened around the neck. During the whole course of after-treatment, the atmosphere of the room should be kept moist and warm (from 75° to 80° Fahr.); the inner tube should be frequently removed and cleansed, and, if the operation have been done for pseudo-membranous croup or diphtheria, lime-water or dilute carbolic acid may, from time to time, be vaporized through the tube with an atomizer. Hypodermic injections of pilocarpine are recommended by Duliscourt and other French surgeons. The expectorated matters should be constantly wiped away, and accumulations of mucus or false membrane removed with a camel's-hair brush, feather, or "elbow-forceps." As soon as the canula can be safely dispensed with, it may be removed, but this should not be done permanently until, by leaving it out for several hours at a time, it has been proved that the function of the larynx has been restored.

If it be necessary to perform bronchotomy in an emergency, and when a tracheal canula cannot be obtained, the surgeon must have recourse to excising an elliptical portion of the tracheal wall, and keeping the edges of the wound apart with retractors made of bent wire (the hooks of ordinary large "hooks and eyes" will answer), secured by an elastic band passing behind the neck. If apnœa persist after a free opening has been made into the windpipe, the surgeon must at once resort to one or other of the methods of practising artificial respiration already described. Dr. Beverley Robinson, of New York, has devised an ingenious "insufflator," by means of which the surgeon can directly inflate the patient's chest through the tracheal tube, without incurring any risk from contact with the secretions of the part. This instrument, or a double-acting bellows, as recommended by Dr. B. W. Richardson, should be employed in case suffocation is threatened by false membrane accumulating below the opening in the trachea; or, if neither of these be at hand, an ordinary hand-ball syringe (reversed) may be used, as suggested by Dr. Green, of Brooklyn.

Choice of Operation.—The relative advantages of *laryngotomy* and *tracheotomy* are still a matter of dispute among practical surgeons. Tracheotomy is preferred in all cases by Mr. Marsh, and laryngotomy, or laryngo-tracheotomy, by Mr. Holmes, especially among children. Mr. Erichsen recommends laryngotomy for adults, and tracheotomy, above the thyroid isthmus, for children; while Mr. Durham considers that the advantages of opening the trachea below the isthmus, as compared with its risks and difficulties, are greater than those afforded by making the opening higher up. While I do not believe that any rule of universal application can be safely laid down upon this question, I would advise, in general terms, that *tracheotomy above the isthmus* should be preferred, in all cases in which time is afforded for a careful and deliberate operation, but that if great haste is essential, *laryngotomy*, which may readily be converted subsequently into *laryngo-tracheotomy*, should be performed instead. When the operation is required by the presence of a foreign body in the windpipe, a more definite rule may be given. If the offending substance be lodged in the larynx, that part itself must usually be opened, though Dr. Lefferts, of New York, has under these circumstances successfully employed Malgaigne's and Langenbeck's operation of *sub-hyoidean pharyngotomy* (see Chap. XXXVIII.), but if the foreign body be in any other part of the air-passages, tracheotomy is the operation to be chosen. The risks of tracheotomy, *per se*, are not very great, death in fatal cases usually resulting from a continuance of the disease rather than from the operation. The result of the procedure, in my own hands, has been to save six out of fifteen cases.

INJURIES OF THE ŒSOPHAGUS.

Wounds.—These have already been alluded to in describing penetrating wounds of the neck, the treatment of which injuries is complicated by the œsophageal wound, through the difficulty thence arising in administering the necessary amount of nutriment. A patient with wound of the gullet, may be fed through an elastic gum catheter, introduced through the mouth, or, if, with suicidal intent, he refuse to separate the jaws, through the nose. By this means a pint of beef-essence, or of "eggnog," may be introduced two or three times a day, until the power of deglutition returns. If the wound is above the position of the larynx, suffocation may occur from the supervention of œdema of the glottis—an accident which would call for the immediate performance of laryngotomy.

Rupture of the Œsophagus is a rare form of injury of which Charles, of Belfast, has collected 15 cases; to these may be added one observed by Dr. William Hunter, and others recently reported by Dr. J. S. Bailey, of Albany, and Dr. G. O. Allen, of Boston. The accident has usually occurred during the act of vomiting, and the symptoms are intense pain with collapse, followed by death in the course of a few hours. According to Fitz, the affection is still rarer than would be indicated by the above figures, many of the reported cases being, in the opinion of this author, really instances of post-mortem softening and perforation.

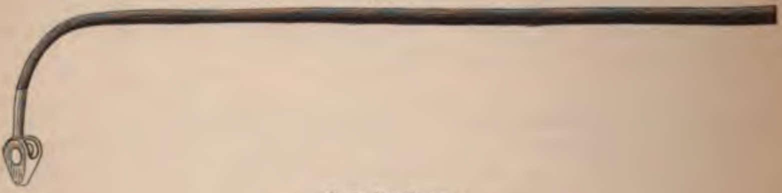
Foreign Bodies in the Pharynx or Œsophagus.—Foreign bodies not unfrequently become impacted in some portion of the food-passage (usually, according to H. Allen, either at the position of the cricoid cartilage, or just above the crossing of the left bronchus), and produce not only great irritation and difficulty of swallowing, but may even induce suffocation by pressure on the windpipe. The *symptoms* vary with the nature, size, and position of the foreign body. A fish-bone, bristle, or pin may be caught between the tonsil and half-arches of the palate, and give rise to much discomfort, with tickling cough, dysphagia, and nausea. A pointed body in this situation may even perforate an important vessel, and thus cause death by hemorrhage. A bolus of food, arrested at the summit of the œsophagus, may suffocate the patient by pressure on the larynx; or, again, a hard body, such as a bone or tooth-plate, may, if impacted, produce ulceration of the œsophageal walls, and penetrate into the larynx, or other important structures in the neighborhood.

The *diagnosis* is usually sufficiently evident from the sensations of the patient, but in any case of doubt, the surgeon, besides carefully inspecting the pharynx in a good light, should sweep his finger around the part as far as he can reach, and cautiously explore the œsophagus with a well-oiled probang. In some cases the laryngoscope may be used to facilitate the examination of the upper portion of the gullet. Though the foreign body can thus usually be discovered, if present, a small substance, such as a fish-bone, may, from the peculiarity of its position, elude detection even after careful and repeated exploration; on the other hand, the sensations of the patient may continue to indicate the impaction of a foreign body for a long period, when none is really present, and œsophagotomy has actually been performed, on more than one occasion, without any substance being found which could account for the patient's symptoms.

FIG. 180.

Burge's œsophageal forceps.

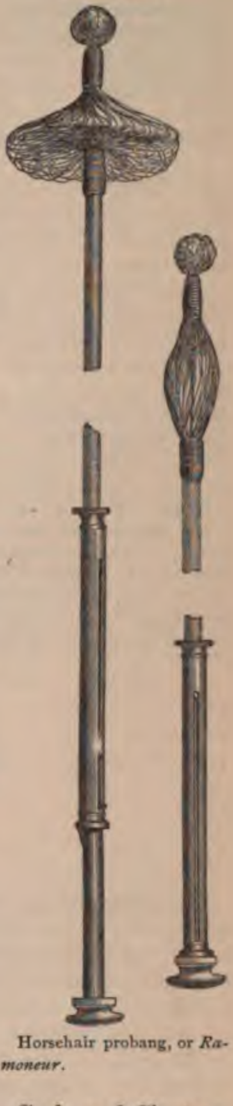
FIG. 181.



Swivel probang.

Treatment.—If suffocation be threatened, unless the foreign body can at once be seized and removed, tracheotomy should be resorted to without delay. In every case an effort should be made to extract the foreign body through the mouth, and this can usually be done, either by simply hooking it out with the finger (if lodged in the pharynx), or by the cautious use of œsophageal forceps (Fig. 180), or of the horse-hair, or swivel probang. Dr. Lamm, a Swedish surgeon, has succeeded in washing out a foreign body from the œsophagus by syringing through a flexible catheter. If the foreign body be of such a nature that it will not be likely to produce injurious consequences in the stomach and bowels, as a lump of meat, or even a small coin, it may, if its extraction prove difficult, be pushed onwards into the stomach, with a sponge or ivory-headed probang.[1] If, as occasionally though rarely happens, a foreign body in the gullet can be neither extracted, nor otherwise disposed of, it should be removed through an external incision, by the operation known as *pharyngotomy* or *œsophagotomy*.

FIG. 182.



Horsehair probang, or *Ramoneur*.

Œsophagotomy.—If the foreign body can be felt externally, the operation should be done on that side which is the most prominent; otherwise the left side is to be chosen, as the œsophagus naturally inclines somewhat in that direction. The patient should be anæsthetized, and placed in a supine position, with the head and shoulders a little raised, and the face somewhat averted. An incision, four or five inches long, is made in the space between the trachea and the sterno-mastoid muscle, beginning above, on a level with the top of the thyroid cartilage. This incision is cautiously deepened, the omo-hyoid muscle, and the outer fibres of the sterno-hyoid and sterno-thyroid, being divided if necessary; the carotid sheath is carefully drawn outwards, and held with a blunt hook, the trachea and thyroid gland being similarly drawn inwards. If the foreign body can now be felt, the œsophagus may be incised directly upon it; otherwise a sound or curved forceps should be introduced through the mouth, and made to project in the wound, thus affording a guide to the point at which the gullet should be opened. The incision may be subsequently enlarged either upwards or downwards, and the foreign body extracted with the finger or forceps.

Special care must be taken in this operation not to wound either the inferior thyroid artery or the recurrent laryngeal nerve. The incision should be allowed to heal by granulation, the patient being fed through a catheter, as after an accidental wound of the œsophagus. This operation is essentially that which has been successfully performed by Syme, Cock, and Cheever, and seems to me in every way preferable to that by a median incision, which was recommended by Nélaton. The *results* of œsophagotomy for the removal of foreign bodies are quite encouraging, 44 cases to which I have references having given 35 recoveries and only 9 deaths.

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[1] An English surgeon, Dr. Stewart, has recorded a case in which a *live fish* was thus successfully disposed of.

Cases of Œsophagotomy for Removal of Foreign Bodies.

No.	Operator.	Result.	No.	Operator.	Result.
1.	Alexander.	Recovered.	23.	Goursauld.	Recovered.
2.	Antoniesz.	"	24.	Hitchcock.	"
3.	Arnold.	"	25.	Inzani.	"
4.	Arnott.	Died.	26.	Hodgen.	"
5.	Atherton.	Recovered.	27.	Id.	"
6.	Id.	"	28.	Kronlein.	"
7.	Bégin.	"	29.	Langenbeck.	"
8.	Id.	"	30.	Id.	"
9.	Billroth.	"	31.	Id.	Died.
10.	Id.	"	32.	McKeown.	Recovered.
11.	Id.	"	33.	Maclean.	"
12.	Id.	Died.	34.	McLean.	"
13.	Cazin.	Recovered.	35.	Id.	"
14.	Cheever.	"	36.	Martini.	Died.
15.	Id.	"	37.	Péan.	Recovered.
16.	Id.	"	38.	Roland.	"
17.	Id.	Died.	39.	Sonnenberg.	"
18.	Cock.	Recovered.	40.	Sonrièr.	"
19.	Id.	"	41.	Stanley.	Died.
20.	De Lavacherie.	"	42.	Syme.	Recovered.
21.	Demarquay.	Died.	43.	Westmoreland.	Died.
22.	Flaubert.	"	44.	Wheeler.	Recovered.

NOTE.—Twenty-two of the above cases are derived from Dr. D. W. Cheever's table, in the *Medical and Surgical Report of the Boston City Hospital*, first series (1870), page 522. In the cases numbered 16, 24, 30, 33, and 43, no foreign body appears to have been found. I have not included in the table two operations by Mr. Syme, and one by Dr. Gay, in which the foreign bodies had already made their way through the œsophagus by ulceration, and which cannot, therefore, strictly speaking, be considered as cases of œsophagotomy.

CHAPTER XVIII.

INJURIES OF THE CHEST.

CONTUSIONS.

Contusions of the Thoracic Parietes, Unaccompanied by Visceral Injury, are usually of but trifling importance; if there be much pain attending the act of respiration, the surgeon should fix the injured side with broad strips of adhesive plaster, precisely as in a case of fractured ribs. An occasional consequence of severe contusion of the chest is the formation of an abscess beneath the pectoral muscle; suppuration in this situation may continue for a considerable time without being recognized, pointing at last probably in the axilla. The local symptoms are necessarily obscure, consisting mainly in great pain, and general swelling of the whole pectoral region; should, however, these symptoms follow an injury, and coincide with the constitutional evidences of the existence of deep-seated suppuration, the proper treatment would be to cut down in the direction of the muscular fibres, enlarging the exploratory incision subsequently as much as might be necessary.

Contusion, Accompanied by Rupture of the Thoracic Viscera, without corresponding fracture, and without external wound, is a rare and dangerous accident, which may result from the contact of a spent ball or piece of shell, from being run over, from falls from a height, etc.

Rupture of the Lung has been occasionally observed, under these circumstances, and cases are recorded by several writers, in which, in spite of the severity of the injury, the patients recovered. The symptoms are those of wounded lung—pneumothorax, with, perhaps, emphysema, hæmothorax, hæmoptysis, and, at a later period, pleurisy and pneumonia, with accumulation of pus or serum in the pleural cavity. The mechanism of the lesion in these cases is, doubtless, as pointed out by Gosselin, that, at the moment of injury, the lung is distended by inspiration, and the glottis spasmodically closed, thus preventing the lung from yielding to the sudden pressure. I have seen two cases of this kind—one at the Pennsylvania Hospital, under the care of Drs. E. Hartshorne and C. C. Lee, in which the left lung was ruptured and which proved fatal on the third day; and another which was under my own care at the Episcopal Hospital, in which the injury affected the right lung, death following on the fifth day. In the latter case the rupture was superficial, and there was no hæmoptysis, though the symptoms of hæmothorax, pneumothorax, and pleurisy, were well marked. This rare form of injury is chiefly met with in young persons.[1] It appears to be less fatal in military than in civil life; 35 cases which I have collected, and which resulted from various forms of violence other than gunshot injury, having given only 11 recoveries, while 25 cases recorded by Dr. Otis as having occurred during our late war, gave the same number. The *treatment* of this form of injury is that which will be presently described as appropriate to wounds of the lung.

Cases of Rupture of the Lung without Parietal Injury.

No.	Reporter.	Result.	No.	Reporter.	Result.
1.	Adams.	Died.	19.	McDonnell.	Died.
2.	Ashhurst.	"	20.	Marsh.	"
3.	Bermond.	"	21.	Nelson.	"
4.	Bouilly.	Recovered.	22.	Poland.	"
5.	Butlin.	Died.	23.	Pollock.	Recovered.
6.	Id.	"	24.	Saussier.	"
7.	Id.	Recovered.	25.	Sée.	"
8.	Churchill.	"	26.	Senfft.	"
9.	DaCosta.	"	27.	Smith.	Died.
10.	Gosselin.	"	28.	Id.	"
11.	Id.	"	29.	Id.	"
12.	Gould.	"	30.	Watson.	"
13.	Gross.	Died.			
14.	Harlan.	"	a.	Hewson.	"
15.	Hilton.	"	b.	Nankivell.	"
16.	Johnson.	"	c.	Rogers.	"
17.	Lee.	"	d.	Tatum.	"
18.	McDonnell.	"	e.	———	"

NOTE.—In the cases numbered 1–30, in the above table, there was no fracture; in those marked a–e, there was fracture, but not corresponding to the seat of injury in the lung, and therefore to be considered a mere coincidence.

Rupture of the Heart, under similar circumstances, is, I believe, invariably, though not always instantly, fatal. Gamgee has collected 28 cases of rupture of this viscus (including one observed by himself), in 9 of which there was no fracture, and "either no bruise of the thoracic parietes or a very slight one." The pericardium was intact in at least half of the cases, and of 22, in which the precise seat of lesion was noted, the right ventricle was ruptured in 8, the left in 3, the left auricle in 7, and the right in 4.[1] The longest period during which any patient survived the injury was fourteen hours. Barth has collected 24 cases of *spontaneous rupture of the heart* (*i. e., not traumatic*), and in every instance the seat of the lesion was in the *left ventricle;*[2] in some of these cases the cardiac wall appears to have given way by repeated slight lacerations, death not having ensued in some instances for several (2–11) days after the first manifestations of serious symptoms. *Internal ruptures*, that is, of the valves or septa, are less serious lesions than those involving the cardiac walls: recovery followed in a case of this kind recorded by Dr. Todd. According to Terrillon, internal rupture is most apt to occur when the heart is in diastole.

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[1] In a discussion at the Clinical Society of London, reported in the *British Medical Journal* for March 11, 1882, a number of cases of *spontaneous* rupture, causing pneumothorax, are referred to.

Concussion of the Lung.—Le Gros Clark has described as a "serious functional derangement without organic lesion," a condition of the lung, resulting from external violence, and very analogous to *concussion* of the brain; the symptoms are dulness on percussion, with diminished respiratory murmur, on the injured side, and puerile respiration on the other, attended with great dyspnœa, but without cough or expectoration. The symptoms disappear in so short a time (forty-eight hours) as to forbid the idea of any very serious organic lesion.

Other Complications, which are sometimes met with in connection with contusions of the chest, are *Pleurisy and Pneumonia, Carditis and Pericarditis, Cerebral Congestion*, from interference with the respiratory function, as when a man is partially buried beneath a falling bank of earth, and *Inflammation and subsequent Suppuration in the Mediastina.* It has been proposed to trephine the sternum, in order to evacuate an abscess in the anterior mediastinum, but the symptoms, while suppuration was confined to the substernal region, could hardly be sufficiently distinct to warrant the operation, while it would, of course, be unnecessary if the abscess pointed on either side.

Wounds.

Non-penetrating Wounds of the chest usually present no features of special interest. The surgeon should be very cautious in his examination of these injuries, lest he should unfortunately convert the wound into one of the penetrating variety. Hence the finger should be used in preference to the probe, and if foreign bodies are to be removed, this should be done with the utmost gentleness. The *diagnosis* must be founded chiefly on the absence of those symptoms which attend *penetrating* wounds, though certain of these (as hæmoptysis) may be present, without the thoracic cavity being directly involved. It is said by Mr. Poland, and some other writers, that *traumatic emphysema* may accompany non-penetrating chest wounds, the air being, as it were, sucked into the subcutaneous areolar tissue by the motion of the thoracic walls in respiration; but while I would not deny the possibility of such an occurrence, it must at least be extremely rare, and the presence of emphysema must certainly be considered as strong presumptive evidence that the pleural cavity is implicated. The *treatment* of these injuries must be conducted on those principles which guide the surgeon in the management of similar wounds in any other part of the body; advantage may often be derived (especially in cases of oblique punctured or gunshot wounds, burrowing subcutaneously for a considerable distance) from the use of broad adhesive strips, to fix the chest, and thus lessen the chance of the formation of a fistulous track, the presence of which would greatly delay recovery.

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[1] Dr. Packard has reported a case of traumatic rupture of both auricles and of the inter-auricular septum.

[2] Spontaneous ruptures have, however, been observed by Dr. Beckett, Dr. Tenison, and Dr. Duffey, in the *right auricle*, and by Dr. Lansing in the *right ventricle*.

Non-penetrating wounds of the chest may be attended with troublesome and even dangerous *hemorrhage*, from lesion of an *intercostal*, or of the *internal mammary, artery*, though these vessels are more frequently involved in cases of penetrating wound. The treatment would consist in the use of ligatures, or, if these could not be employed, in the application of a compress and firm bandage.

Penetrating Wounds.—These may be best studied by considering in succession—1. Wounds of the pleura and lung; 2. Those of the pericardium and heart; 3. Those of the aorta and vena cava; and 4. Those of the anterior mediastinum.

1. Wounds of the Pleura and Lung.—The costal pleura alone may be wounded, the pulmonary pleura and lung being uninjured. This is more apt to occur with *incised* wounds than with those of any other variety. There is no symptom, however, on which the surgeon can rely, to distinguish these cases from those in which the pulmonary tissue itself is involved, and which are certainly of more frequent occurrence. A wound of the lung may exist as a complication of fracture of the ribs, as was mentioned in a previous chapter; the injury in such a case, being of the nature of a subcutaneous lesion, is of a less serious character than a wound communicating with the external air.

Symptoms.—These are usually well marked. The *shock* is in most cases very decided, there is great *dyspnœa* (the respiration being chiefly diaphragmatic), with *pain* at the seat of injury, and a short, tickling *cough* which is very distressing to the patient. *Hæmoptysis* is usually, but by no means invariably, present, the expectorated matter being frothy mucus mixed with blood, or more rarely pure blood in considerable amount. *Emphysema* and *pneumothorax* (the former consisting in the diffusion of air through the areolar tissue, and the latter in an accumulation of air in the pleural cavity) are very constant symptoms of lung wounds, though they may accompany wounds involving the pleural cavity only: emphysema, indeed, according to some writers, being met with in cases of non-penetrating wound. *Tromatopnœa* is, perhaps, more characteristic than any other single symptom of a wound of the lung, though I have witnessed it in cases in which there was every reason to believe that the pleura alone was injured, and it is said by Fraser to be occasionally present in wounds in which even the pleural cavity is entirely unhurt; it consists, as its name implies, in air passing in and out of the wound during the act of respiration. *External hemorrhage* is of course present in greater or less amount in every case of penetrating wound of the chest, but a more serious symptom is hemorrhage into the pleural cavity, giving rise to the complication known as *hæmothorax*. *Hernia of the lung*, *pneumocele*, or *pneumatocele* is a rare sequence of penetrating wounds of the chest, and is more apt to occur after cicatrization of the external wound, than as a primary phenomenon. *Pneumonia* and *pleurisy*, in the ordinary sense of these words, are very seldom met with, though inflammation, limited to the track of the wound, probably occurs in most cases of lung wound which are not rapidly fatal, *effusion of serum* and *empyema* being occasional and very grave complications of the later stages of the injury. *Collapse of the lung* is probably a less frequent occurrence in penetrating chest wounds than was formerly supposed. It appears, when present, to depend upon the compression caused by pneumothorax, or by the various forms of liquid effusion.

Diagnosis.—This can commonly be made without difficulty, by noting the presence or absence of the various symptoms above enumerated. It is to be observed, however, that no one of them is in itself pathognomonic, and the warning cannot be too often repeated, that no exploration with a probe or finger should be made in any case of doubt.

Prognosis.—The prognosis in any case of wound of the lung should be very guarded, at least during the first three days, though in a person of healthy constitution, with care and judicious treatment, recovery may often be obtained. Of the different varieties of wound, the *incised* or *punctured* are less dangerous than the *lacerated* and *contused*, and, of gunshot wounds, those which are *perforating*, or *through and through*, give more favorable results than those which are merely *penetrating*, the missile or other foreign body lodging in some part of the thoracic cavity. The *mortality* after gunshot wounds of the chest, accompanied by lesions of the thoracic viscera, was, in our army during the late war, nearly 63 per cent. Wounds of the *root* of the lung are much more fatal than those of the *surface*.

Treatment.—Under this head I shall first describe the treatment applicable to lung wounds in general, considering afterwards such modifications as may be required by those conditions which are sufficiently important to be regarded as complications. The *Local Treatment* varies according to the nature of the wound. If it be *incised* or *punctured*, the external opening should be, as a rule, immediately closed with sutures, and covered with a compress and bandage, which should not be removed for at least five or six days. By this time, in a favorable case, the visceral lesion will have been repaired, and, if the external wound itself have not united, it will have been converted into a comparatively superficial injury. In the case of a gunshot wound, as the part will necessarily slough, the surgeon should content himself with removing all foreign bodies that can be discovered without dangerous interference, then applying a light dressing of wet lint or some similar substance. Dr. B. Howard, reviving an old suggestion, has proposed, under the name of "hermetically sealing" chest wounds, to pare the edges, thus converting the external opening into an incised wound, and then to bring the edges together with sutures and collodion. The records of the Surgeon-General's Office, however, show that, though ingenious in theory, this method is unsuccessful in practice, 42 out of the 69 cases in which it was tried during our late war having certainly proved fatal, and but 3 of the remaining 27 being looked upon by Dr. Otis as authentic instances of complete and permanent recovery. Whatever be the nature of the wound, great comfort may often be afforded the patient by fixing the injured side of the thorax with broad strips of adhesive plaster, an opening being of course left opposite the wound. If hæmoptysis be present, ice should be freely applied to the chest. With regard to the *Constitutional Treatment* appropriate to cases of wound of the lung, considerable difference of opinion at present exists among practical surgeons. Until within a few years it was customary to advise venesection in almost all cases, both to arrest hæmoptysis and as a prophylactic against subsequent pneumonia. Absolute diet was invariably directed, and antimony or mercurials administered on the first suspicion of inflammatory action. The credit of the first formal protest against the common practice of venesection in these cases is due, I believe, to Dr. Patrick Fraser, who gave the results of extended personal observation during the Crimean war, in an interesting monograph, published in 1859. The correctness of the views which Dr. Fraser advanced has been amply confirmed by the experience of military surgeons since that time, and, for my own part, I can testify that, in civil practice, I have found no reason to adopt a different mode of treatment from that which has proved successful in the surgery of war. "In the treatment of penetrating wounds of the chest," says the author of Circular No. 6, "venesection appears to have been abandoned altogether. Hemorrhage was treated by the application of cold, perfect rest, and the administration of opium. These measures seemed to have proved adequate generally, and no instances are reported of the performance of paracentesis or of the enlargement of wounds for the evacuation of effused blood." Still more emphatic language is used by Confederate Surgeons:—

> "Equally unphilosophical and more injurious, in our opinion, than even the use of the last class of sedatives [antimonials], is the time-honored absurdity of venesection. It comes to us embalmed in the dicta of 'the highest authority,' and consecrated by the owlish wisdom of 'the ancients,' and, until recently, the precept has met with submissive and unquestioning acquiescence. We are gratified to find that in all the cases of arterial hemorrhage collected in the office of the inspector, *not one* is reported wherein the expedient was practised by a Surgeon of the Confederate States. . . . For *traumatic* pulmonary hemorrhage the measure appears to us not only hazardous, but actually injurious."[1]

The constitutional treatment which I would recommend, in any case of wound of the lung, whether from gunshot or other form of injury, consists in the adoption of those measures which are adapted to facilitate the work of nature in the reparative process. *Profound quiet* and *rest*, both physical and mental, should be rigidly insisted upon. The *diet* should consist of such substances as are most easy of digestion, and which are yet sufficiently nutritious. Milk is probably here, as in other severe injuries, the most generally suitable article of food. *Opium* should be freely administered in almost all cases, its constipating effect being obviated by the occasional use of mild *laxatives* or simple enemata. *Diaphoretics* may be employed if there be marked febrile reaction, and if pneumonia or pleurisy occur, they may be treated as if idiopathic affections, it being remembered that the inflammation in these cases is usually limited to the immediate neighborhood of the seat of injury, and is indeed a part of the natural process by which the existing lesion is to be repaired. Beef-tea and even brandy will, according to my experience, be more often required in cases of lung wound than calomel or antimony.

Complications.—The complications of wounds of the lung which require special consideration, are (1) *hemorrhage* (which may be *external* or *into the pleural sac*), (2) *pneumothorax* and *emphysema*, (3) *hernia* of the lung tissue, and (4) *serous* or *purulent accumulations* in the cavity of the pleura.

(1.) *Hemorrhage* may arise from a wound of the lung itself, or of an intercostal, or the internal mammary, artery: if from a lesion of an *intercostal artery*, the surgeon should enlarge the external wound, and, if possible, secure the injured vessel with double ligatures; if this be impracticable, compression must be employed, either by means of Desault's compress, or *serre-fines*, or, if these will not suffice, by means of manual pressure. Desault's compress, which is well spoken of by Otis, consists of a piece of strong linen or muslin, pressed through the wound, stuffed with lint or charpie, and then drawn outwards against the rib. It has been proposed to facilitate ligation of an intercostal artery by first excising a portion of the adjacent rib, but unless a fracture or other injury of the rib itself rendered such an operation necessary (p. 245), I should scarcely think the surgeon justified in its performance. Hemorrhage from the *internal mammary artery* should be treated by ligation of that vessel, which in the upper intercostal spaces may be reached by an oblique incision, from ¼ to ½ an inch from the border of the sternum, the costal cartilages being, if necessary, divided so as more fully to expose the artery. If hemorrhage proceed from a *wound of the lung* itself, the blood may escape at the cutaneous orifice, may be coughed up through the air-passages, or may accumulate in the cavity of the pleura, giving rise to the condition known as *hæmothorax*. This condition may also arise, though more rarely, from wounds of the intercostal or internal mammary arteries. The *rational symptoms* of hæmothorax are those which characterize loss of blood in general, such as faintness, dizziness, and pallor, with disturbance of the respiratory function, dyspnœa, restlessness, etc. None of these are, however, in any degree pathognomonic, and death from hæmothorax may take place without the previous occurrence of any symptom certainly indicative of wound of the lung. The *physical signs*, when present, are more trustworthy; they consist of enlargement of the injured side of the chest, with bulging of the intercostal spaces; absence of respiratory murmur, and dulness on percussion—gradually increasing in extent, and the line of dulness varying with the posture of the patient; the sensation of a wave of fluid, or of splashing, felt by the patient, or transmitted to the hand of the surgeon on succussion; and finally, according to Valentin and Larrey, œdema and ecchymosis in the lumbar region. All of these signs, except the last (which is by no means constant, and is, indeed, looked upon by Fraser and Otis as somewhat apocryphal), may be equally present in cases of serous or of purulent accumulation, and hence it is only by their appearance immediately after the injury, and in coincidence with other signs of hemorrhage, that the surgeon can satisfy himself as to the nature of the case. The *treatment* of hemorrhage, from wound of the lung, would consist in closing the external wound by means of a firm compress, in the application of ice, and in the administration of opium and ergot, with perhaps digitalis or veratrum viride: by these means, in a favorable case, coagulation of the effused blood, and subsequent occlusion of the bleeding vessels, may be obtained, the clot being gradually absorbed, and the patient recovering without further trouble; if, however, the bleeding continue into the pleural sac, as marked by increased dulness on percussion, with dyspnœa, and the other symptoms of hæmothorax above enumerated, the original wound must be reopened, or, if it have already healed, paracentesis must be performed, as in a case of empyema.

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[1] A Manual of Military Surgery, prepared for the use of the Confederate States Army, page 97. Richmond, 1863.

(2.) *Pneumothorax* and *Emphysema* usually coexist in the same case, though either may be present without the other. By the act of *inspiration* the air is sucked into the pleural cavity, either through a cutaneous wound or from the ruptured air-vesicles of the lung, while in *expiration*, the orifice by which the air entered being closed by the valve-like action of the surrounding structures, it is pumped into the areolar tissue, *pneumothorax* thus usually preceding *emphysema*. If, however, there be old pleural adhesions, or if the external wound correspond exactly with that in the lung, the air may pass directly in and out (*tromatopnœa*), without invading either the pleural sac or the planes of connective tissue. *Pneumothorax* alone may result from rupture of the lung, without injury of the costal pleura, while *emphysema* alone may result from puncture of the lung through an old pleural adhesion, from rupture of an air-cell or bronchus into the posterior mediastinum (according to Hilton),[1] or possibly, as taught by Poland and others, from a non-penetrating wound of the chest. *Pneumothorax* is marked by great resonance on percussion, with absence of the respiratory murmur, by amphoric respiration, and occasionally by metallic tinkling; if excessive, it produces much dyspnœa. *Emphysema* is characterized by a diffuse, puffy, colorless, perfectly elastic swelling, crackling under pressure; it can scarcely be mistaken for any other condition. It is very seldom that either of these complications requires special *treatment*. Pneumothorax, if existing on both sides, might threaten suffocation, and the proper treatment in such a case would be to evacuate the contained air by puncturing the chest with an aspirator or very small trocar, closing the wound immediately afterwards with a strip of adhesive plaster. Emphysema, if very extensive, might require the application of a bandage, or even scarification of the most distended parts.

(3.) *Hernia of the Lung.*—This rare form of accident, of which Desfosses has collected twenty examples, six occurring spontaneously and fourteen consecutively, or as the result of injury, may occur as a subcutaneous lesion, the result of crushing violence to the chest, or even, it is said, of straining efforts during parturition. It may also occur in the site of a cicatrix, as in an instance mentioned by Velpeau. The tumor under these circumstances is soft, somewhat circumscribed, elastic, compressible, increasing in expiration and diminishing in inspiration, communicating a distinct impulse on coughing, crepitating when handled, and measurably disappearing when the patient holds his breath; the tumor is resonant on percussion, and the seat of a loud respiratory murmur; the limits of the aperture through which it has escaped may often be distinguished by palpation. The *treatment* consists in effecting and maintaining reduction, by means of a compress and bandage, if this be possible, and if not, in the application of a concave pad, so as to protect the part from injury, and prevent further protrusion. Hernia of the lung sometimes takes place through an open wound, usually in the neighborhood of the nipple: if the projecting lung tissue be healthy, it may be cautiously pushed back, the orifice through which it escaped being slightly enlarged if necessary; if gangrene have occurred, however, the protrusion should not be interfered with, the part being left to be removed by sloughing.

(4.) *Hydrothorax* and *Empyema*, the former term denoting a collection of serum and the latter one of pus, in the pleural sac, are occasional complications of the later stages of wounds of this part. The *symptoms* are those of chronic pleuritic effusion, from whatever cause (the physical signs being the same as those which were mentioned in speaking of hæmothorax), and the *diagnosis* is to be made, principally, by observing the later period of occurrence and the more gradual increase of the symptoms, and, in the case of empyema, the tendency which is sometimes manifested to the formation of an external opening. Empyema, according to the elder Pepper and other authors, is particularly marked by bulging of the lower intercostal spaces, and dilatation of the superficial veins; but Bowditch doubts the possibility of more than *suspecting* the nature of pleuritic effusions, before operation, and founds even this suspicion, mainly, on the previous history of the case. According to Baccelli, of Rome, and Chew, of Baltimore, feebleness or absence of the vocal and respiratory sounds is indicative of the presence of pus, dense fluids transmitting vibrations less readily than others. It is doubtful if any advantage is to be obtained, in the *treatment* of these cases, from the use of medicines designed to promote absorption, such as are employed in the cases of chronic pleuritic effusion which come under the observation of the physician; hence, in any case in which the accumulation is so great as to give manifest tokens of its presence, the surgeon should have recourse to the operation of Paracentesis, which should be performed before the lung has become so bound down by adhesions as to have lost the power of expanding when the source of pressure is removed.

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[1] Seven cases of emphysema occurring during parturition are referred to in the Dublin Journal of Medical Science for March, 1881, p. 286.

Paracentesis Thoracis.—Before resorting to this operation, the surgeon should confirm his diagnosis by the use of an exploring trocar and canula, or, which is perhaps better, an aspirator or a long-nozzled hypodermic syringe, by which a small portion of the accumulated fluid may readily be obtained for examination. The particular operation to be chosen depends somewhat upon the nature of the effusion; if this be serous, the opening should be a small one, and it is here important to guard against the admission of air, by using the suction-trocar proposed by Dr. Wyman and modified by Dr. Bowditch, the aspirator of Dieulafoy, Rasmussen, or Potain, or, if none of these be at hand, a trocar fitted with a stopcock and gum-elastic bag, or with a flexible tube so arranged as to evacuate the fluid under water. For the evacuation of an empyema the same precautions need not be taken, and it is here better to used a full-sized trocar, leaving the canula or an elastic catheter in the wound, or, which is better, introducing a *drainage tube*, one end of which projects at the point of tapping, the other being brought out through a counter-opening at the lowest part of the cavity.[1] *Drainage tubes* (introduced by Chassaignac) consist of pieces of India-rubber tubing, about one-sixth of an inch in diameter, with numerous lateral apertures, made by notching the tube with scissors. Roser, Peltavy, and Estlander recommend that, instead of using a drainage tube, a free opening should be secured by resecting a portion of a rib—a plan which was successfully resorted to by the late Warren Stone, and has since been employed by various surgeons, including T. G. Richardson, Simon, Taylor, Howse, Thomas, Ashby, Marshall, König, Wagner, Lange, and J. William White, of this city. Schneider reports a recovery after excision of portions of *five ribs and the clavicle* for empyema following a gunshot wound. The *point* at which paracentesis should be performed is a matter of dispute; that usually recommended is between the fifth and sixth, or sixth and seventh, ribs, in a line nearly corresponding to the insertion of the serratus magnus muscle. Dr. Bowditch usually taps between the ninth and tenth ribs, while others go as high as the fourth intercostal space; I have usually chosen the sixth or seventh, finding that at a lower point pain may be caused by the diaphragm rising against the instrument, while, if the puncture be made higher, it is difficult to secure full evacuation of the cavity. Whatever point be chosen, the intercostal space should be, if not bulging, at least not contracted; the skin should be incised with a bistoury or lancet, and the trocar thrust in at the upper edge of the lower rib, so as to guard against wounding the intercostal artery—an accident which proved fatal in a case recorded by Gallard. If an ordinary trocar be used (in a case of hydrothorax), the admission of air may be further guarded against by drawing the cutaneous incision to one side before introducing the trocar, thus making a kind of valvular opening; but the calibre of the suction-trocar is so small that, if it be employed, this precaution is unnecessary. The patient, at the beginning of the operation, should be in a sitting posture, and as the fluid is withdrawn should be gently lowered into a supine position, and slightly turned on the affected side; an assistant should steadily compress the lower part of the chest, to prevent syncope, and further to guard against the entrance of air.

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[1] Dr. Phelps, of Chateaugay, N. Y., employs a tube provided with a valve, so as to permit washing out the cavity, while preventing the admission of air.

The after-treatment (as far as the operation is concerned) consists simply in closing the wound with a piece of lint and an adhesive strip. If it be determined (in a case of empyema) to employ a drainage tube, this is introduced as follows: a steel-eyed probe, bent like a sound, is passed through the wound of tapping, and made to project at the lowest accessible intercostal space; upon this, as a guide, a counter-opening is made, and the eye of the probe threaded with a strong ligature carrying the tube, which is thus readily brought into place when the probe is withdrawn; the ends of the tube are then fastened together, and the wounds covered with wet lint, or other simple dressing. The cavity should be thoroughly washed out at least once a day with a dilute solution of iodine or carbolic acid, so as to prevent putrefaction of the contained pus and consequent septicæmia. Dr. Hutchinson exhibited to the College of Physicians, of this city, a patient in whose case this plan had been systematically carried out with complete success, the punctures healing readily when the tube was removed, and recovery following without the occurrence of any reaccumulation. The *statistical results* of the operation of tapping the chest are quite satisfactory; of 526 terminated cases collected by G. H. Evans, no less than 373 ended in recovery, while only two of the 153 deaths were attributable to the operation itself.

In a case of *Empyema following a Gunshot Wound*, in which there was reason to suspect the presence of a foreign body, the surgeon should carefully explore the cavity with a probe, after evacuating the contained fluid, when, if a ball, or other foreign body, should be discovered, it should be removed with suitable forceps, as was successfully done by Larrey. Purulent collections in the *lung* have been opened by tapping or incision in several cases by Lawson, Godlee, Erichsen, Mosler, Pepper, Lyell, and other surgeons.

2. Wounds of the Pericardium and Heart.—*Wound of the Pericardium alone* would not appear to be as fatal an injury as would naturally be supposed; at least 51 cases collected by Fischer gave only 29 deaths, and as many as 22 recoveries, the diagnosis in three of the latter being subsequently confirmed by post-mortem inspection, when the patients died from other causes.

Wounds of the Heart are usually, though not necessarily, fatal; 401 cases, collected by Fischer, afforded as many as 50 recoveries, the diagnosis in 33 of the latter being eventually confirmed by means of an autopsy. The *symptoms* of these injuries are not very definite; if the wound be large, there is, of course, profuse *hemorrhage*, which may prove almost instantly fatal; punctured wounds are, however, often attended with little or no bleeding, owing chiefly to a peculiar arrangement of the muscular fibres of the heart, described by Pettigrew, by which a wound which is transverse to one layer of fibres is in the direction of another layer, and therefore, to a certain extent, necessarily valvular. *Syncope* is often observed in cases of heart wound, occurring not unfrequently at the moment of injury. *Pain*, when present, is, according to Fischer, due to the pericardial lesion. If effusion of blood, or serum, take place into the cavity of the pericardium, the *sounds of the heart* and the *cardiac impulse* are diminished in intensity. A *systolic bellows sound* is the most usual abnormal murmur observed in cases of heart wound. *Precordial anxiety*, *dyspnœa*, and other symptoms are not distinctive, and, indeed, are occasionally entirely wanting. The *diagnosis*, which, as may be inferred from what has been said, is often obscure, may be additionally complicated by the coexistence of a wound of the lung, as happened in a case which I observed some years ago. The *prognosis* should, of course, be very guarded. Recovery, however, may occasionally follow, and instances have been recorded by Ferrus, Latour, Fournier, Randall, Carnochan, Balch, Hamilton, Hopkins, Gallard, Tillaux, Conner, and others, in which patients have survived heart wounds for considerable periods, even though with foreign bodies lodged in the substance of the organ. Callender has recorded a remarkable case in which he successfully removed a *needle* which was fixed in the substance of the heart. The *treatment* of a suspected wound of the heart would consist in keeping the patient at absolute rest, and in the application of cold, the administration of opium, digitalis, veratrum viride, etc., and, if death were threatened by pericardial effusion, perhaps the performance of paracentesis. *Paracentesis Pericardii* may be performed in the fourth or fifth intercostal interspace, with the same precautions that were recommended for the operation of tapping the pleural sac. Of 41 cases collected by Dr. J. B. Roberts, of this city, 22 proved fatal, but mostly from causes unconnected with the operation. Rosenstein records a case of purulent pericarditis successfully treated by free *incision*.

3. **Wounds of the Aorta and Vena Cava** are almost invariably fatal. Cases are, however, recorded by Pelletan, Heil, and Legouest, in which patients survived wounds of the aorta for from two months to several years.

4. **Wounds of the Anterior Mediastinum** are less serious than any other penetrating wounds of the chest; the *symptoms* are often rather obscure, being, indeed, in many instances, chiefly negative, and the *diagnosis* depends on the absence of those signs which characterize wounds of the lung. Some of these signs may, however, be present; thus, *emphysema*, and, according to Fraser, even *tromatopnea*, may accompany wounds of the mediastinum which do not involve the lung or pleura. The chief dangers of these injuries are hemorrhage (from the internal mammary artery), diffuse inflammation, and suppuration. Death may result from pressure of the accumulated pus on the heart or lungs, or from pyæmia. The *treatment* of a wound of the mediastinum is that which has been directed for other penetrating wounds of the chest: if suppuration occur, the matter should be evacuated where the abscess tends to point, at one or the other side of the sternum.

Injuries of the Diaphragm.

The diaphragm may be *ruptured* by external violence, as by a fall on the chest or abdomen, by violent squeezing, as in railway accidents, or (as in a case referred to by Mr. Pollock) by spasmodic contraction of the part itself. The usual seat of laceration, in these cases, is the left side, in the fleshy portion of the muscle. If the injury be uncomplicated by lesion of abdominal or thoracic viscera, the prognosis is not so unfavorable as might be supposed: unless, however, the laceration be very limited in extent, protrusion of the stomach or other abdominal viscera into the cavity of the chest will almost inevitably occur, constituting the condition known as *Diaphragmatic Hernia*. *Wounds* of the diaphragm, resulting from stabs, gunshot injuries, etc., are usually complicated with other serious lesions, and it is from these, rather than from the wound of the diaphragm itself, that the danger in these cases chiefly arises. The *symptoms* of a wound of the diaphragm are very obscure; in most instances there is great dyspnœa, breathing being principally carried on by the subsidiary muscles of respiration. Dr. C. T. Hunter has, however, recorded a case of gunshot wound, in which the ball, after perforating the stomach, bowels, and diaphragm, lodged in the thoracic cavity, but in which there was no difficulty of breathing until shortly before death, the dyspnœa even then evidently resulting mechanically, from gaseous distension of the intestines. The *treatment* of a wound of the diaphragm is essentially the same as that recommended for penetrating wounds of the chest.

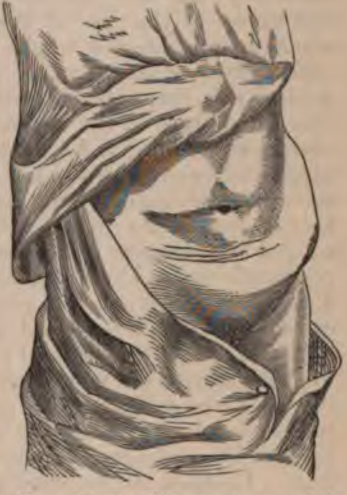
CHAPTER XIX.

INJURIES OF THE ABDOMEN AND PELVIS.

CONTUSIONS OF THE ABDOMEN.

Contusions of the Abdomen, unattended by Lesions of the contained Viscera, are rarely attended with much risk. It is popularly believed that *sudden death* not unfrequently results from a blow on the epigastrium, no morbid appearance being discoverable on post-mortem inspection; the possibility of such an occurrence has, however, been shown, by Mr. Pollock's researches, to be at least doubtful, though there can be no question that *rapid* death may follow these injuries, either from concomitant shock, or from a condition of the solar plexus analogous to cerebral concussion. In either case, however, there would probably be physical lesions which could be recognized after death.

FIG. 183.



Ventral hernia, following rupture of the abdominal muscles. (From a patient in the Episcopal Hospital.)

Rupture of the Abdominal Muscles may occur without the existence of any external wound: these ruptures have usually been observed in the recti muscles, though they may occur in any portion of the abdominal parietes. The accident is very apt to be followed by a form of ventral hernia, which may sometimes attain a very large size, as in the patient whose case is represented in the annexed figure, and who received his injuries by being run over by the wheel of a cart. The *treatment* of such a case consists in the application of a truss with a broad and somewhat concave pad, to restrain the protrusion. There is little risk of strangulation, on account of the large size and yielding character of the hernial aperture. I have several times seen, in soldiers, a ventral hernia in the median line, resulting from separation of the tendinous fibres in the linea alba, and caused, apparently, by the fatigue of long marches and the weight of the knapsack. The treatment consists in the application of a pad and elastic bandage.

Abscess of the Abdominal Parietes occasionally follows contusion of the part, and may cause great destruction of tissue by extending between the muscular planes. The *treatment* consists in early evacuation of the pus, by means of free incisions so arranged as to permit drainage.

Contusions of the Abdomen, attended with Lacerations of the Abdominal Viscera, are very grave injuries. Rupture of the *liver, spleen, kidney, omentum,* or *mesentery,* or of any of the large *vessels,* may prove rapidly fatal from internal hemorrhage; while lacerations of the hollow viscera, as the *stomach, bowel,* or *gall-bladder,* or of the *parietal peritoneum,* are principally dangerous on account of the peritonitis which almost inevitably results. *Intestinal obstruction* occasionally follows apparently slight contusion of the abdomen, doubtless from injury to the peritoneum covering the affected portion of bowel. *Encysted dropsy* resulted in a case recorded by Duplay. The degree of risk attending laceration of the solid viscera depends entirely upon the extent of the lesion; thus a superficial laceration of the *liver* may cause merely localized peritonitis, from which the patient may recover; injuries of the *spleen* are more dangerous, on account of the profuse bleeding which attends even slight lesions of this organ, and death usually results, if not from hemorrhage, yet at a later period, from the supervention of diffuse inflammation and suppuration. Laceration of the *kidneys* offers a comparatively favorable prognosis; as was mentioned in Chap. XVI., slight lacerations of these organs are not infrequent in cases of spinal injury, and do not appear necessarily to entail any serious consequences. Ruptures of the *stomach or bowel*[1] are almost invariably fatal; if the seat of laceration should be such that extravasation of the contents of these viscera should take place elsewhere than into the peritoneal cavity (as between the layers of the mesentery, in the case of the bowel), it would be just possible that the resulting inflammation might terminate in an abscess which would point externally, and that recovery might thus follow; but it may be given as a general rule, that ruptures of the stomach or bowel are fatal injuries. Spontaneous rupture of the stomach, the result of excessive vomiting, has been observed by Chiari and Lantschner. Rupture of the *gall-bladder* is almost always followed by death, bile being found in the peritoneal cavity on post-mortem examination; that recovery is at least possible, would, however, appear from a case recorded by Dr. Fergus, in which the patient was considered convalescent, and was walking about, when, on the seventh day, peritonitis was suddenly developed, and proved fatal two days subsequently. Rupture of the *ureter* is a very rare injury; Mr. Poland has collected four cases, one of which recovered, after the evacuation by puncture, at intervals, of about two gallons of fluid resembling urine, the other cases terminating in death, during the first, fourth, and tenth weeks respectively. In none of the cases does it appear that peritonitis was present, the urinary extravasation having occurred into the cellular tissue behind the peritoneum. Ruptures of the abdominal bloodvessels, without other injuries, are seldom met with. Legouest has recorded a case of laceration of the aorta; and Dr. Otis has collected five cases of a similar lesion of the vena cava. I have myself seen death follow an unrecognized rupture of the external iliac artery (see Fig. 81).

Symptoms.—The symptoms of these various forms of injury are rather obscure. There is usually marked shock, with pain, and a sensation of impending dissolution—but not more than is often observed in cases of abdominal contusion unaccompanied by visceral lesion: the *persistence* of collapse, however, with other evidences of internal hemorrhage, will give reason to suspect rupture of a solid viscus, or of a portion of the peritoneum which contains large vessels; while the immediate development of peritonitis would indicate rupture of one of the hollow viscera. Pain in the right hypochondrium, with increased hepatic dulness, and, at a later period, bilious vomiting, clay-colored stools, and the presence of sugar in the urine, would afford evidence of laceration of the *liver;* hæmaturia would indicate lesion of the *kidney*, though its absence would, by no means, prove that this organ had escaped; hæmatemesis would be a symptom of ruptured *stomach*, and bloody stools of ruptured *intestine*—a lesion, the existence of which might also be suspected, if the abdominal wall were the seat of *emphysema*, the diagnosis of which from emphysema due to thoracic injury, and from gaseous putrefaction, might be made by observing the history of the case, and the coincident symptoms. The history may also serve, sometimes, to distinguish between *gastric* and *intestinal* laceration, rupture of the stomach rarely occurring except when that organ is distended by a recent meal.

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[1] Dr. Whitney has pointed out that, in cases of *ante-mortem* rupture of the intestine, the mucous membrane is invariably found *everted;* this is not the case as regards ruptures produced after death.

Treatment.—As these injuries are in the majority of instances necessarily fatal, their treatment must, of course, be often merely euthanasial. As far as any curative influence can be exerted by remedies, it must be (as Sir Thomas Watson puts it) in *obviating the tendency to death.* Hence the surgeon's first efforts must be directed to arresting the internal hemorrhage which is the source of immediate danger, and at a later period to combating the peritonitis which is the common cause of death in those cases which survive the early periods of the injury. The patient should be put to bed, and kept profoundly quiet; if the symptoms of shock be very prominent, cautious efforts may be made to induce reaction, preferably by the application of external warmth, for it must be remembered that internal stimulation might increase the risk of hemorrhage. Opium may be freely administered, both to relieve the sufferings of the patient, and as an anti-hemorrhagic remedy; to increase its efficiency in the latter respect, it may be advantageously combined with acetate of lead. The older writers recommended venesection in these cases, on the same principle on which it was employed in the treatment of penetrating wounds of the chest; but I imagine that there are few surgeons at the present day who would employ bleeding under these circumstances.

The *local treatment* should consist (at this stage) in the application of cold to the abdomen—dry cold applied by means of an ice bag or box (see page 55), or, if these be not at hand, cloths wrung out of cold water and frequently renewed. The diet should be mild and unirritating, and if there be reason to suspect laceration of the stomach or bowel, the patient should be exclusively fed by means of nutritive enemata. If great suffering should be caused by gaseous distension, the surgeon would be justified in puncturing the bowel with a fine trocar, through the linea alba, as recommended by T. Smith. It does not appear that this little operation is in itself attended with any particular risk,[1] and it would certainly be permissible as an euthanasial measure. Retention of urine should be obviated by the use of the catheter. An exploratory operation, to seek for the laceration and close it by sutures, has been suggested in these cases, but, it seems to me, would but add to the patient's danger.

Traumatic Peritonitis.—It is probable that slight and circumscribed peritonitis occurs in almost every case of severe abdominal injury which recovers, but it is the existence of diffuse peritoneal inflammation, attended with the effusion of turbid serum, or with suppuration, that constitutes the chief danger to be apprehended in the later stages of these injuries. The symptoms of traumatic peritonitis do not differ from those of the idiopathic variety of the affection, and for their description I would therefore refer the reader to works on the Practice of Medicine. The course of traumatic peritonitis is very rapid, death from this cause sometimes occurring in less than twenty-four hours from the time of reception of the injury. The *treatment* varies with the general condition of the patient, and the supposed nature of the internal lesion. I have never had occasion to employ general bleeding in these cases, but I have applied *leeches* or *cups* (in cases occuring among those of robust health and vigorous constitution), and, I am sure, with advantage. The amount of blood drawn may vary from 8 to 12 ounces, and the immediate mechanical relief thus afforded to the inflamed peritoneum is sufficient, I think, to compensate for the evils which inevitably attend all forms of bloodletting. In an old or feeble person, however, or in a very young child, I should consider even local bleeding highly improper. The application of a large *blister* is usually recommended in these cases, and I have myself employed it. I am not sure, however, that a jacket-poultice, enveloping the whole abdomen, might not be equally efficient, as it would be probably more agreeable to the patient. I have found advantage from the use of the *veratrum viride*, in doses of 3 or 4 drops of the tincture, every three hours, simply as a means of reducing the rapidity of the heart's action and the force of the circulation; the remedy is, however, a dangerous one, and its effects should be carefully watched, its administration being suspended as soon as the pulse falls to the normal average. *Opium* is an invaluable remedy in cases of traumatic peritonitis, and may be freely given in every instance. Dr. Alonzo Clark's rule is to give two grains, more or less, every two hours until the patient's respiration has been reduced to *twelve* in the minute. Unless laceration of some part of the alimentary canal be suspected, this drug may be suitably combined with small doses of *calomel;* but in cases of intestinal rupture, the effect of the latter substance would be to increase the risk of fecal extravasation, and in such a case, if mercury be used at all, it should be employed by inunction. *Milk diet* is that which is best adapted to cases of traumatic peritonitis, wine or brandy being added if necessary. If the stomach or bowel be lacerated, nutritive enemata, of beef-tea, egg-nog, etc., must be substituted. If serous effusion persist after the subsidence of acute symptoms, an attempt may be made to promote absorption by the use of blisters, and by the administration of iodide of potassium.

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[1] Fonssagrives has collected 84 cases of puncture of the bowel for tympanites, showing that the operation is not particularly dangerous, but his views are contravened by Piorry and Fräntzel, who regard the procedure as one which is full of peril.

Retro-peritoneal Suppuration, resulting from rupture of the intestine between the layers of the mesentery, might possibly require incisions to evacuate the pus; and similar treatment would be indicated in the event of *Urinary Extravasation* occurring from laceration of the kidney or ureter.

Wounds of the Abdomen.

Non-Penetrating Wounds of the abdominal parietes present few peculiarities requiring special mention. Foreign bodies are to be removed, and the wound cleansed, as in other localities. Hemorrhage in these cases cannot safely be controlled by pressure, simply because there is no surface to furnish counter-pressure, while closure of the external wound will not suffice, because it would allow interstitial bleeding to continue, and thus dissect up the intermuscular spaces; therefore, if, in any case, the hemorrhage be greater than mere oozing, the part must be freely exposed (the wound, if necessary, being enlarged for this purpose), and the bleeding vessel secured by ligature, torsion, or acupressure. These wounds are apt to gape, and, hence, if extensive, require the use of sutures, muscular relaxation being secured by position. *Ventral Hernia* may occur after cicatrization, and would require the application of a truss or bandage.

Penetrating Wounds.—These may be divided into—1. Those without protrusion or wound of the abdominal viscera; 2. Those without protrusion, but with wound of such viscera; 3. Those with protrusion of unwounded viscera; and 4. Those with protrusion and wound of viscera.

1. *Penetrating Wounds of the Abdomen, without Protrusion or Wound of the Contained Viscera,* may result from stabs, bayonet thrusts, or gunshot injuries. The diagnosis from non-penetrating wounds is often difficult, and any exploration with a probe would be manifestly improper. The escape of bloody serum, or the occurrence of emphysema, may be taken to indicate penetration of the peritoneum, and the diagnosis will be confirmed should peritonitis subsequently occur. The *treatment,* in such a case, would be the same as in one of non-penetrating wound, visceral complications being managed on the principles already laid down in speaking of visceral rupture without external wound.

2. *Penetrating Wounds, with Wound of the Abdominal Viscera, but without Protrusion.*—The diagnosis of these cases from those of the last category, can usually be made only by observing the flow of the visceral contents through the external wound, or by noting a very rapid development of peritonitis, which, when resulting from extravasation of the visceral contents, occurs more quickly than under other circumstances. In a remarkable case of gunshot wound of the stomach, recorded by Culbertson, of Ohio, the diagnosis was however rendered clear by the detection of several shot in the matter vomited by the patient immediately after the reception of the injury. The *treatment* of a case of this kind would consist in placing the patient in such a position as to allow any matter that might be extravasated to escape externally, in the free administration of opium, and in the adoption of such measures generally as would tend to moderate the peritonitis, which would almost inevitably ensue. It is recommended, in such a case, by Legouest, Otis, Dugas, and other high authorities, to enlarge the external opening, search for the source of extravasation, and apply sutures to the wounded viscus; but the prospective benefits of such a proceeding would, it seems to me, be extremely questionable, while the additional risks that it would entail are manifest. When the patient recovers, after an injury of this kind, it is usually with a gastric, biliary, urinary, or fecal fistula, according to the part which has been wounded.

3. *Penetrating Wounds, with Protrusion of Unwounded Viscera.*—Portions of almost any of the abdominal organs may protrude, if the wound be a *large* one, and instances are not wanting in which recovery has followed the protrusion, under such circumstances, of parts of the stomach, liver, spleen, or other viscera. In these cases, the wound being large, there is commonly not much difficulty in reduction, which should always be practised in the case of such organs as have been mentioned. If the bladder protrude, reduction may be much facilitated by the use of the catheter. If, as occasionally happens, a portion of a solid viscus, such as the liver, spleen or pancreas, be strangulated and already gangrenous when first seen by the surgeon, a strong ligature should be applied, when the sloughing mass may be either cut away or allowed to separate spontaneously. Recoveries under these circumstances have been reported by several surgeons, and Dr. Otis has collected a number of such cases in the second volume of the *Surgical History of the War.*

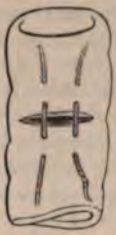
The parts which are liable to protrude through *small* wounds are the bowels, mesentery, and omentum. The *treatment* of such cases would depend upon the condition of the extruded viscera. If *Bowel* protrude, and be found *healthy*, or only *moderately congested*, it should be at once returned. This may sometimes be effected by drawing down a further portion of the gut, and gently pressing upwards the fecal contents, so as to diminish the tension of the protruded mass. In other cases it may be necessary to enlarge the wound—just as in the analogous case of operation for strangulated hernia. This *débridement*, as it is called, should be made in an upward direction, and should be confined, if possible, to the skin and muscular tissues, the peritoneal aperture usually yielding without incision. If reduction be rendered impossible by gaseous distension of the protruded bowel, the surgeon would be justified in puncturing the part with a grooved needle, as has been successfully done by Mr. Tatum and others. Dr. Storrs, of Hartford, Conn., recommends that the lips of the wound should be drawn upwards and separated by means of blunt hooks or ligatures, previously introduced. Reduction should be aided by placing the patient in such a position as will insure relaxation of the abdominal walls, and the portion of bowel which has *last* descended must be *first* returned. The surgeon must take care that reduction is really accomplished, and that the protruding part is not merely thrust up between the planes of the abdominal parietes. If the protruded bowel be *gangrenous*, it would not be safe to attempt reduction, and, in such a case, the part should be freely incised, and the patient allowed to recover, if possible, with a fecal fistula. What course should be adopted, if the bowel, though not absolutely gangrenous, be intensely inflamed? It is usually advised, under these circumstances, to effect reduction and close the wound, but I am not sure that it might not sometimes be better to allow the part to remain *in sitû*, after dividing any constricting bands that might threaten strangulation. The risk of peritonitis would, at least, not be increased by this plan, while, if the bowel should subsequently give way, there would be less danger of fecal extravasation. The course to be pursued in case of *Omental Protrusion* likewise depends upon the state of the part; if this be healthy, it should be at once returned, but if violently inflamed, or if gangrenous, it should be excised—the part immediately above being first transfixed and tied with a double ligature, to prevent hemorrhage, and the stump being secured in the deeper portion of the wound, by fastening the ligatures, with adhesive strips, to the abdominal wall.

The treatment to be pursued *after reduction*, consists in accurately closing the wound with numerous sutures (which should embrace the whole thickness of the abdominal wall, *except* the peritoneum), and in adopting means to moderate the peritonitis which may be expected to occur. If omentum have been excised, the cutaneous wound should be closed over the ligated stump, the ligatures being brought out between the points of suture. If bowel have been left in the wound, with anticipation that a fecal fistula will follow, the part should be lightly dressed, with oiled lint or some similar substance, so as to exclude the air, and keep the wound from dust.

4. *Penetrating Wounds, with Protrusion and Wound of Viscera.*—If a solid viscus be affected, the treatment would consist in reduction, or (in the case of the omentum) perhaps in partial excision, according to the rules above laid down. Hemorrhage from a mesenteric artery should be arrested by torsion or ligature. Wounds of the stomach or bowel require the application of sutures, the part being subsequently returned into the abdominal cavity, and the after-treatment being conducted as in cases of the previous category. The suture employed should, in case of a large wound, be the *continued* or

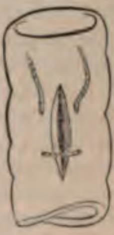
glover's suture (Fig. 70), applied through all the coats except the mucous, or, which is preferable if the wound be transverse, Lembert's or Gely's modification. These have for their object the inversion of the edges of the wound, and the consequent coaptation of the serous surfaces (Figs. 184, 185), and seem to me, upon the whole, quite as satisfactory as the more complicated methods of Vézien, Bouisson, and Bérenger-Féraud. The suture being applied, both ends are to be cut short, and the whole replaced in the abdominal cavity. The suture (which should be of silk or thread) gradually finds its way into the interior of the bowel, and is eventually discharged *per anum*. For small longitudinal wounds the common interrupted suture may suffice, while a mere puncture may be closed by simply throwing around it a ligature, the wounded point being raised for the purpose with tenaculum or artery forceps. If, on the other hand, a transverse wound involve the *whole calibre* of the bowel, it is probably better to secure the edges of each extremity of the gut to the external wound, and allow the formation of a fecal fistula. This course would, I think, be safer, under such circumstances, than an attempt to restore the continuity of the bowel by means of sutures.

FIG. 184.



Lembert's suture.

FIG. 185.



Gely's suture.

In the after-treatment of all these cases the free administration of opium is of the highest importance. The patient must be kept perfectly quiet, purgatives strictly interdicted, and food given as much as possible in the form of nutritive enemata.

Gastric Fistula is a condition by no means incompatible with long life and comfort. If small, an attempt may be made to promote contraction and cicatrization by occasional cauterization of the edges; but if large, the surgeon should ordinarily content himself with applying a suitable compress, or obturator. Billroth, however, has successfully resorted to *gastrorraphy*, splitting the edges of the fistula and closing the gastric opening with sutures, and then covering the external wound with a flap taken from the neighboring integument.

Biliary Fistula, of which I have seen but one example, scarcely admits of any treatment, except keeping the parts clean and removing any gall-stones that may become impacted.

Urinary Fistula, following a wound of the ureter inflicted in ovariotomy, has been successfully treated by Gussenbauer by a process of *ureteroplasty*, which consists in dilating the sinus and then establishing an artificial passage between the cut ureter and the bladder. Similar operations are attributed to Nüssbaum and Tauffer.

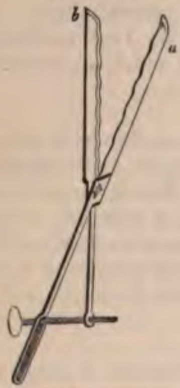
Fecal or Intestinal Fistula (usually called *Artificial Anus*) is more frequently met with after strangulated hernia than after a wound, but the treatment in either case is the same, and I shall, therefore, consider it here.

If the opening into the bowel be but small, the greater portion of the fecal mass being evacuated in the natural way, it may be sufficient to keep the parts clean, and to apply a firm compress, which, with occasionally touching the edges with nitrate of silver, will sometimes effect a cure; or the fistula may be carefully laid open, and its sides brought together with deep stitches

—a proceeding by which I succeeded in effecting a cure in a case sent to me by Dr. Benjamin, of Camden. If, however, the opening be larger, and still more if the whole calibre of the gut be involved, the condition is different. In such a case the ends of the bowel adhere by their serous surfaces, their position at the bottom of the external wound having been not inaptly compared to that of the tubes of a double-barrelled gun. The lower end of the bowel, being unused, undergoes contraction, while the upper extremity is frequently abnormally dilated. The mesenteric portion becomes prolonged between the ends of the gut into a kind of spur, which acts as a valve in further occluding the lower opening. In some cases the junction of the two ends of bowel is at a considerable depth from the surface, the fecal contents finding their way to the external wound through a long and perhaps sinuous canal.

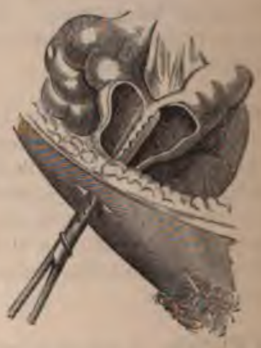
The *treatment* consists, if Desault's plan of continuous compression fails, in dividing the "*éperon*," or spur-like projection between the intestinal extremities, so as to restore the continuity of the bowel, and in subsequently freshening the edges of the external wound, which is then closed with harelip pins—or in performing a plastic operation, if the simpler procedure fail. The division of the spur may be accomplished in several ways, the best probably being by means of the *enterotome* devised by Dupuytren. The enterotome consists of two serrated blades (Fig. 186, *a*, *b*), which are introduced, one into each end of the bowel, and which are then approximated, and fixed by means of a screw. This screw is tightened day by day, so as to cause the adhesion of the adjoining surfaces of the bowel, and the removal of the septum by sloughing; if this be done too quickly, the peritoneal sac will be opened, and death will probably occur from fecal extravasation. Another risk is the possibility of pinching a knuckle of healthy intestine between the blades. The tightening of the screw must be very gradually effected, the time required for safe division of the septum being at least a week. In a case in which the lower end of the bowel could not be found, Laugier opened the large intestine at another part, and, introducing one blade of a modified Dupuytren's enterotome through each wound, succeeded in this manner in restoring the continuity of the gut. To avoid the risk of premature perforation, Dr. David Prince has recently suggested the use of a wire loop and pin, by which the sides of the septum are invaginated, while the necessary pressure is afforded by an elastic cord which connects the pin

FIG. 186.



Dupuytren's enterotome.

FIG. 187.



Enterotome applied. (ERICHSEN.)

and loop outside of the body. Perforation being effected, the little instrument is made to cut its way out through the septum by means of another elastic cord, attached to a miniature "derrick" which is fixed upon the surface of the abdomen. Other plans are Physick's, which consists in bringing together the sides of the septum with a ligature, and in subsequently dividing the part below; and Schmakhalden's, which consists in transfixing the septum with a ligature, which is then forcibly tied, and allowed to cut its way out. Various modifications of Dupuytren's method have been proposed by Liotard, Delpech, Gross, and others. During the application of the enterotome, the patient should be kept fully under the influence of opium. As soon as the continuity of the bowel has been restored, the edges of the external wound may be pared and brought together with the twisted suture, or, as suggested by Duncan, the edges may be split, the mucous surfaces being invaginated and secured with catgut sutures, while the external wound is closed with silver wire; or, if simpler measures fail, an attempt may be made to close the opening by means of a plastic operation. Schede has in three cases resorted to *Enterorraphy*, dissecting out the ends of the bowel, under antiseptic precautions, and bringing them together with stitches, fecal extravasation during the operation being prevented by a temporary ligature thrown around the proximal end of the gut. Two of the three cases terminated successfully. Enterorraphy has also been practised by Kuester, Billroth, Dumreicher, Dittel, and other surgeons, 12 cases collected in Hayem's *Revue des Sciences Médicales* (Avril, 1880) having given 6 recoveries and 6 deaths.

Foreign Bodies, such as coins, pins, buttons, or artificial teeth, are not unfrequently swallowed, and may lodge in the stomach or bowels. The domestic treatment of such cases is usually the administration of a purgative —a remedy which is, however, really unsuitable, as the object should rather be to delay peristaltic action, and to allow the foreign body to become enveloped in a mass of fecal matter, so that it may produce less irritation in its onward passage. If the foreign body cannot be extracted through the mouth, as has been successfully done in one instance by L. S. Little, and is of such a nature (as a table knife, or fork) that it cannot probably be either dissolved by the gastric and intestinal juices, or naturally evacuated, the surgeon would, I think, be justified, provided its position could be ascertained by external palpation, in attempting its removal by operation. *Gastrotomy* has, including Labbé's case, been successfully performed under these circumstances in at least seven instances;[1] and, as death would be, sooner or later, almost inevitable without operation, the attempt would be at least permissible.[2] The incisions, in such a case, should be regulated by the size and shape of the body to be removed, and the after-treatment should be the same as for an incised wound accidentally inflicted. *Enterotomy* might be similarly resorted to, if the foreign body, having reached the bowel, should cause complete intestinal obstruction (see Chap. XLII.). J. C. McKee has recorded a remarkable case in which a piece of wire was accidentally swallowed, and, having made its way into the abdominal parietes, was safely removed by external incision nearly four months afterwards.

[1] Dr. Otis has collected 12 cases, not including Labbé's; the histories of 5 are more or less open to question, and, of the remaining 7, 1 terminated fatally. Poulet refers to 15 cases, of which 10 are said to have ended in recovery. Another case, the result of which has not been ascertained, has since been recorded by Fleury and Jurkowski.

[2] See, however, this question discussed by Poland (who considers the operation unnecessary) in *Guy's Hosp. Reports*, 3d s., vol. ix.

Injuries of the Pelvic Organs.

Injuries of the Bladder.—The bladder may be *ruptured* (without external wound) by violence,[1] as a kick, applied to the abdomen. This accident is only likely to happen if the organ be distended with urine, as when empty it sinks beneath the pubic arch, and is thus measurably protected from external injury. The rupture usually occurs in the posterior wall of the bladder, involving the peritoneal as well as the other coats of the organ, and allowing urinary extravasation into the peritoneal cavity, an event which is almost inevitably fatal, 98 cases collected by Bartels having given but 4 recoveries. More rarely the rent is confined to the anterior wall of the bladder, urine then escaping into the pelvic areolar tissue, and inducing a condition which, though very grave, is not so uniformly fatal as the one previously referred to, 12 out of 54 such cases collected by Bartels having terminated favorably. The symptoms, in the former case, consist of intense epigastric pain, collapse, urgent but fruitless efforts to urinate, and in a short time the ordinary signs of peritonitis; the introduction of the catheter serves to evacuate either none or a very small quantity of bloody urine. If the peritoneum be not involved, the symptoms are less urgent, the patient being, in these cases, gradually worn out by diffuse inflammation and sloughing of the areolar tissue. The *treatment* consists in the introduction of a large flexible catheter, which (as a general rule) should be secured in place, the urine being allowed to run off constantly, by means of an attached India-rubber tube, into any convenient receptacle. The patient should be got as soon as possible under the influence of opium, a warm poultice may be placed over his epigastrium, and concentrated food or stimulants administered, if indicated by his general condition. *Diaphoresis* should be encouraged by external applications, it being an obvious indication to promote the vicarious action of the skin, and thus diminish the amount of urine secreted. It has been suggested to perform *cystotomy* (as in the median or lateral operation for stone), in these cases, and if it were found impossible to keep the bladder empty by means of a catheter, the operation, which has been successfully resorted to, under these circumstances, by Walker, of Massachusetts, and by Parker and Mason, of New York, would be certainly proper, and would, I think, be preferable to opening the bladder either through the rectum or above the pubes, though the latter procedure also has been successfully employed by a New York surgeon, Dr. Williams. Holmes suggests that it might be justifiable to open the abdomen and close the vesical wound with sutures, but the cases in which Willett and Heath tried the operation terminated fatally. A similar operation was suggested some years ago by Prof. Gross, and is said to have been successfully resorted to by Dr. Walter, of Pittsburg. Free incisions should be made on the first outward manifestation of urinary infiltration having occurred. A few instances are on record, in which the bladder has been ruptured by the accumulation of its own secretion; such an accident, however, is very rare, the urethra usually giving way, in such cases, rather than the bladder.

Wounds of the Bladder are amongst the most serious complications of fractures of the pelvis. The bladder may also be wounded by gunshot projectiles, by pointed instruments, by the horns of infuriated animals, etc. When the wound is in that part of the organ which is covered with peritoneum, these injuries are usually fatal, but there are numerous instances of recovery from wounds of the bladder inflicted in the *perineal* region. The

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[1] Assmuth reports two cases of rupture from muscular action.

treatment of these cases is essentially that which has been described in the preceding paragraph; any foreign body that may have lodged in the bladder should be removed, as its continued presence would produce great irritation, and probably cause the formation of a calculus. If the wound be through the rectum or vagina, a troublesome fistula may result, requiring, perhaps, the performance of a plastic operation.

Foreign Bodies, such as slate pencils, pins, etc., may be introduced into the bladder, through the urethra, through an external wound, or, more rarely (by the process of ulceration), from another viscus—as in a remarkable case recorded by Dr. Kingdon, in which a pin, having been swallowed, lodged in the appendix vermiformis, from which it subsequently made its way into the bladder, where it formed the nucleus of a calculus; the ulceration by which this process was attended gave rise to the formation of an intestino-vesical fistula, through which no less than six round worms entered the bladder, and were at different times discharged from the urethra. Foreign bodies may occasionally be spontaneously expelled from the bladder—or may be extracted with urethral forceps, or a small lithotrite, if the surgeon succeed in catching them in the direction of their long axis. In the *male*, however, it is usually necessary to resort to lithotrity (if the nature of the body admit of its being crushed), or to lithotomy, the *median* being in such a case the preferable operation. From the *female* bladder, foreign bodies may be conveniently removed, in most cases, by dilating the urethra with two- or three-bladed forceps, or with graduated bougies, until the forefinger can be introduced, when it is very easy with forceps to seize and extract the foreign body, the finger serving to adjust it into a favorable position for removal. It occasionally happens that, in using the *female catheter*, the instrument slips from the fingers, and is sucked into the bladder. In the event of such an unfortunate occurrence, the surgeon should *at once* dilate the urethra and remove the foreign body. I have known fatal ulceration to result, under these circumstances, from the delay of only a few days.

Injuries of the Rectum.—*Wounds* of the rectum, provided that they are uncomplicated, usually heal without much difficulty, as is seen after the operation for fistula, or when the bowel is accidentally wounded in lithotomy. If the lesion involve the bladder or vagina, recto-vesical or recto-vaginal fistula will probably result, and may require the performance of a plastic operation. Death may follow perforation of the rectum (from the peritoneum being opened), as has occasionally happened from the incautious use of syringes, or of rectal bougies.

Foreign Bodies are occasionally found in the rectum, and must be removed with scoop or forceps, as the ingenuity of the surgeon, and the exigencies of each particular case, may suggest. *Linear rectotomy* may be required, as in cases recorded by Raffy and Turgis (see Chap. XLII.). The removal of masses of impacted feces, of seeds or fruit-stones, etc., may often be accomplished simply by the repeated use of warm enemata. A fish-bone, or similar article, may be caught in one of the pouches of the rectum, and, by the resulting ulceration, give rise to a fistula in ano.

Injuries of the Penis and Male Urethra.—*Wounds of the Penis*, if limited to the skin, are not attended with any particular risk; they always require the use of sutures, on account of the retractile tendency of the part. In deeper wounds there may be profuse hemorrhage, which may require a ligature, if it proceed from any recognizable artery, but which, if of the nature of general oozing, may be checked by cold and pressure, the latter being best applied by introducing a full-sized catheter, and then compressing the organ upon this with adhesive strips. *Contusion, or Partial Rupture*, of the corpora cavernosa, is followed by interstitial extravasation of blood, attended by marked induration, and sometimes by priapism, which may persist for several days. Such an injury is best treated by the continued application of evaporating lotions. *Strangulation* of a portion of the penis is sometimes produced in children by tying a string round the part, or, in adults, by the introduction of the organ into a metallic ring, the neck of a bottle, etc. If gangrene has not been induced, the symptoms will usually quickly subside upon the removal of the source of constriction. Nélaton, Heyenberg, and Moldenhauer have reported remarkable cases of *luxation* of the penis, the organ being completely separated from its cutaneous covering, and buried in the adjoining tissues. In Nélaton's case reduction was effected by the use of forceps.

The Urethra may be Wounded by cutting instruments, or gunshot projectiles, or may be *Lacerated* by falls or blows upon the perineum or penis, by injuries received during coitus, or even by violent straining efforts at micturition in cases of stricture. It may also be wounded in rude attempts at catheterization, giving rise to the formation of "*false passages*." The *symptoms* of laceration of the urethra are pain, considerable swelling from interstitial bleeding, hemorrhage from the meatus, and inability to urinate. If the patient, by straining, succeed in passing water, *Urinary Extravasation* will usually occur, giving rise to extensive destruction of tissue, and the formation of perineal fistulæ. This is less likely to happen in cases of "false passage" than in those of other varieties of urethral laceration, because in the former the direction of the passage is away from the course of the urine. The *treatment* consists in the immediate introduction of a full-sized catheter (flexible, if possible), which must be retained for several days, until the subsidence of pain and swelling renders it probable that the laceration has healed; the catheter should not be plugged, lest the accumulating urine find its way by the side of the instrument. If it be impossible to introduce a catheter, the surgeon must at once open the urethra in the perineum, when, if the instrument still cannot be passed, a flexible tube may be introduced through the wound into the bladder. This I believe to be safer, in these cases, than puncture through the rectum or prostate, or above the pubes. If extravasation of urine have occurred, free incisions must be made in the perineum, scrotum, and inside of the thighs, or wherever the urine may have reached, to permit the escape of the irritating fluid, and facilitate the separation of sloughs. Laceration of the urethra, according to its extent, will probably result in an intractable form of stricture, or even in complete obliteration of a portion of the tube, with the persistence of an incurable perineal fistula.

Foreign Bodies in the urethra may be extracted through the meatus, with urethral scoop or forceps (or, in some cases, as suggested by Keyes, of New York, with a Thompson's stricture expander), or through an incision in the median line. If this incision be in the perineum, the wound may be allowed to heal by granulation, a full-sized catheter, or bougie, being passed every other day: but if in the penile portion of the urethra, sutures will be required, and in this case a flexible catheter should be retained until union has occurred. When the foreign body is long and soft (as a bit of catheter), an ingenious plan of removal, suggested by Van Buren and Keyes, may be adopted: this consists in transfixing the foreign body with a stout needle passed through the floor of the urethra, and pushing back the canal as far as possible, like a glove over a finger, then withdrawing the needle and transfixing again, and so gradually coaxing the foreign body forwards until it can be seized at the meatus.

Injuries of the Scrotum and Testes.—*Wounds of the Scrotum* require the application of sutures; if the wound be extensive, the testis may be extruded, owing to the great contractility of the dartos muscle. In order to effect relaxation of the part, Mr. Birkett advises the use of warm fomentations before the application of stitches, cold lotions being afterwards substituted to produce contraction and prevent bagging. *Contusion* of these parts is followed by great swelling and ecchymosis, and often results in the formation of a hydrocele, or hæmatocele. *Wounds of the Testis* usually heal readily, the tunica vaginalis, in such cases, commonly becoming obliterated by inflammation. Atrophy of the organ is said to occasionally follow these injuries.

Injuries of the Prostate.—Incised wounds of the prostate heal without trouble, as is seen in cases of lithotomy. The prostate is sometimes wounded in rude attempts at catheterization, causing retention of urine and urethral hemorrhage; the *treatment* consists in introducing a large flexible catheter, or, if this be impossible, in tapping the bladder through the rectum or above the pubes.

Injuries of the Spermatic Cord and Vas Deferens.—*Wounds of the Spermatic Cord* require the use of the ligature, or other means of checking hemorrhage, and the divided segments of the cord should be brought together with a stitch, in hope of procuring union. Mr. Hilton has met with several cases of *Rupture of the Vas Deferens*, marked by arterial hemorrhage from the urethra, with great pain and fever, and followed by atrophy of the corresponding testis. The *treatment* is that which is appropriate for ordinary deep-seated inflammation.

Injuries of the Uterus.—Injuries of the *Unimpregnated Uterus* are very rare, and could scarcely occur except in combination with other more serious lesions. Injuries of the *Pregnant Uterus*, beside the risks of hemorrhage and peritonitis, are extremely apt to terminate in abortion. The *treatment* of such cases must be conducted upon the principles which have been laid down for the management of cases of severe injury to the abdominal viscera in general. If the fœtus be partially or completely extruded from the womb, it must be removed, *per vias naturales*, or through the external wound, if there be one, according to the particular circumstances of the case. *Rupture of the Womb, Occurring during Parturition*, is not a subject properly within the scope of this work.

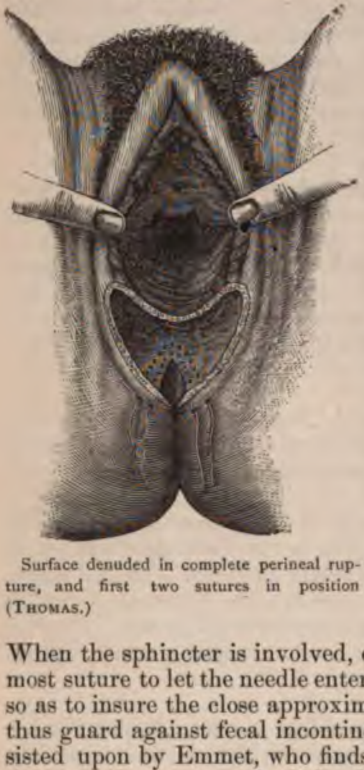
Laceration of the Cervix Uteri is an accident of not unfrequent occurrence during labor, and may require an operation, which consists essentially in freshening the edges of the rent with suitably curved scissors, and fixing them with metallic sutures which are allowed to remain for about ten days.

Injuries of the Vulva and Vagina.—*Contusions and Wounds* of these parts are to be treated on the principles which guide the surgeon in the management of similar injuries in other regions of the body. Women are sometimes seriously wounded, while in the act of micturition, by the breaking under them of chamber utensils, and fatal hemorrhage has occasionally resulted, under these circumstances, from a wound of the internal pudic artery. The *treatment* would consist in plugging the wound with lint, dipped in a solution of the persulphate or perchloride of iron, and in the application of a compress and firm bandage. *Foreign Bodies* occasionally become impacted in the vagina, or may be thrust through its walls into the bladder, rectum, or peritoneal cavity. The *treatment* consists in the removal of the offending substance by such means as the ingenuity of the surgeon may suggest, and in the subsequent adoption of measures to combat the resulting inflammation. Injuries of any portion of the "genital zone," received during pregnancy, are, as pointed out by Guéniot, apt to be followed by abortion.

Injuries of the Perineum.—Wounds of the *Male Perineum*, not involving the urethra, commonly heal without much difficulty.

Lacerations of the Female Perineum occasionally occur during labor, and, if at all extensive, usually require an operation for their cure. If the case be seen within twelve hours after the occurrence of the laceration, it will probably be sufficient to approximate the parts with deep and superficial sutures, maintaining the thighs in apposition until union has occurred, and insuring cleanliness by frequent syringing with a solution of permanganate of potassium. At a later period it will be necessary, after emptying the bowel by means of an enema, to draw away the anterior wall of the vagina with a duck-billed speculum, and freshen the edges of the opening (making a raw surface at least an inch in depth, and extending the whole length of the fissure), then accurately adjusting the parts with the quilled suture, as recommended by Brown, or simply with the interrupted suture, as done by Sims, Emmet, and Agnew. In either operation two sets of sutures may be properly employed; a deep set—entering an inch from the cut edge, passing as deep as the denudation extends, and coming out an inch from the cut edge on the opposite side—and a superficial set to insure more accurate adjustment of the cutaneous surfaces. When the sphincter is involved, care should be taken in passing the hindmost suture to let the needle enter and come out far back towards the coccyx, so as to insure the close approximation of the separated muscular fibres, and thus guard against fecal incontinence. This precaution is particularly insisted upon by Emmet, who finds that its neglect frequently allows the persistence of a recto-vaginal fistula. If the whole recto-vaginal septum be torn, it will be necessary to close this by numerous interrupted sutures passed from the vaginal surface, and, in these cases, it may be desirable to divide the sphincter ani on either side, as recommended by Brown. If there be great tension upon the deep sutures, a curved incision may be made on either side of the perineum, as recommended by Dieffenbach and T. Smith; Parker, of New York, employs lateral incisions, through the bottom of which he passes sutures of doubled wire, secured over bits of catheter. If the quilled suture be employed, either strong whip-cord or flexible wire may be used. The best material for the interrupted sutures, both superficial and deep, is strong silver wire. The deep sutures are most conveniently introduced by means of a needle fixed in a handle. In the after-treatment, constipation should be maintained by the administration of opium, for about two weeks,

FIG. 188.



Surface denuded in complete perineal rupture, and first two sutures in position (THOMAS.)

and the catheter should be used at regular intervals. Sims and Emmet advise the employment of a short rectal tube, to allow the escape of flatus. The deep sutures may be removed from the sixth to the eighth day, and the superficial set a few days later. Catgut sutures are recommended by Dr. Brickell, of New Orleans, who further modifies the operation by tying the deep sutures over metallic stays placed between the sides of the wound. Dr. Hodgen, of St. Louis, instead of merely freshening the edges of the laceration, dissects triangular flaps from both buttocks, and turns them inwards with their cutaneous surfaces towards the vagina, thus increasing the size of the raw surfaces to be approximated, and furnishing an apron which prevents the vaginal discharges and urine from irritating the wound. A similar plan is adopted by Parker and by Stimson, of New York, and is by the latter surgeon attributed to Langenbeck.

CHAPTER XX.

DISEASES RESULTING FROM INFLAMMATION.

ABSCESS.

AN abscess is a collection of *pus*, surrounded by a wall or layer of *lymph*. Pus existing in a serous cavity (as in *empyema*), or in a joint, does not strictly constitute an abscess (though often so called), any more than pus widely diffused through the cellular tissue, or covering the granulations of an ulcerated surface. Several varieties of abscess are described by surgical writers, as the acute or phlegmonous; the chronic; the cold, lymphatic, congestive, or scrofulous; the diffused (a contradiction in terms); the emphysematous; the metastatic or pyæmic; and the residual. The division which I shall adopt, and which seems to me to be the simplest, is into (1) the *acute* or *phlegmonous* abscess, which may be considered the typical form; (2) the *chronic* or *cold* abscess; and (3) the *residual* abscess. *Diffused Suppuration* (which, according to the definition above given, does not constitute an abscess) will be described in a separate place, and the so-called *Metastatic Abscess* in the chapter on Pyæmia. The presence of gas in an abscess (constituting the *Emphysematous* variety) is a mere coincidence, depending on the locality of the affection, or on the occurrence of putrefaction.

Acute or Phlegmonous Abscess.—When a part that has been inflamed becomes more swollen, the dull pain changing to one of a throbbing or pulsatile character, the skin assuming a deeper hue, and presenting a shining and glazed appearance, the surgeon knows that suppuration is impending, and that an abscess will probably be formed. If the seat of pus-formation be deep-seated, the superincumbent tissues become brawny and œdematous, from infiltration of lymph and effusion of serum, and, as the pus gradually approaches the surface (which it has an almost invariable tendency to do), the overlying tissue becomes softened, the thinnest part bulges forwards, the cuticle often desquamates, fluctuation (which was at first obscure) becomes manifest, and *pointing* of the abscess is said to have occurred. A small circular slough is then formed at the thinnest part, and detached by the outward pressure of the pus, when the abscess discharges its contents, its walls contract by their own elasticity, the cavity is filled by the process of granulation, the remaining superficial ulcer cicatrizes, and the part returns gradually to its normal condition—the scar and loss of substance, however, sometimes persisting for a very long time. The mechanism of pointing has never been explained in a perfectly satisfactory manner. The tissue which intervenes between the abscess and the surface upon which it is to break, is usually said to yield by a combined process of absorption and disintegration: it seems more probable, however, that, under the influence of the inflammatory process, rapid cell-proliferation occurs in the abscess wall, with liquefaction of the intercellular substance, thus forming fresh pus-cells, the number of which is probably still further increased by the direct transit of white blood corpuscles through the parietes of the capillary vessels. The final step consists, as has been mentioned, in a small disk of skin becoming deprived of its vitality, and being then thrown off as a minute circular slough. Though an abscess usually tends towards the cutaneous surface, it may, under other circumstances, break into a mucous canal, into a joint, or even into one of the large serous cavities of the body. A happy provision of nature in the case of abscesses of internal organs (as of the liver), pointing externally, is that localized inflammation and adhesion may open the way for the escape of the pus upon the cutaneous surface, without the intervening serous cavity becoming involved.

Diagnosis.—The diagnosis of phlegmonous or acute abscess can usually be made without difficulty, by attending to the *history* of the case, by observing the disposition to *point*, by noting the presence of *fluctuation* and the other local signs above described, and lastly, if necessary, by using the exploring-needle or trocar. *Fluctuation*, which is the sensation communicated to the surgeon's hands by a wave of fluid, can best be recognized by placing one or two fingers of each hand on the suspected swelling, and making alternate pressure, first with one hand, and then with the other. The fingers should be placed *longitudinally* as regards the direction of the muscular fibres of the part, and it must be observed that in any region in which the muscular and connective tissue is abundant, as in the thigh or nates, or bound down by dense fasciæ or ligaments, as in the temporal region or the back of the hand, a very slight increase of tension from inflammation or effusion will give a deceptive feeling closely analogous to fluctuation. Again, certain tumors, as the cystic, fatty, glandular, or encephaloid, are often attended with fluctuation, and have been frequently mistaken for abscesses. Finally, a partially consolidated aneurism may give the sensation of deep-seated fluctuation, and thus lead the surgeon into error. Hence, in any case of doubt, more especially if the suspected swelling be in the neighborhood of a large artery or other important part, the surgeon should, by all means, confirm his diagnosis by using the exploring-needle, before making a free incision. A better instrument, in some cases, than the ordinary exploring-needle, is the aspirator, or even the common hypodermic syringe. The *temperature* of abscess-cavities has been particularly investigated by Assaky, who finds that it ranges from 99.5° to 101.3° Fahr., gradually diminishing as the abscess heals. The skin over an acute abscess is from 1° to 4.5° hotter than the corresponding part on the other side of the body. This increase of temperature might sometimes prove of diagnostic value, but would not serve to distinguish an abscess from a rapidly growing sarcoma, which affection, as pointed out by Estlander, and as I have found by personal observation, may cause a very considerable augmentation of local heat. The course of the temperature in an abscess is, according to Assaky, quite independent of that of the body in general.

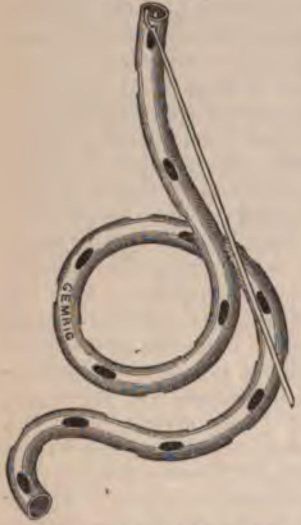
Prognosis.—An acute abscess, unless very large, is usually a comparatively trivial affection. In certain situations, however, even a small abscess may not only, by pressure on nerves or other important structures, cause great pain and discomfort, but may even seriously endanger life. An abscess of the prostate or perineum may cause retention of urine; one of the fauces or throat, dyspnœa and even death; or one of the parotid or a cervical gland, fatal bleeding from the carotid artery or internal jugular vein. The drain from a very large abscess, or from numerous abscesses, may cause death by exhaustion, with or without the development of hectic fever, or by inducing the peculiar form of visceral disease which has received the name of amyloid or albuminoid degeneration.

Treatment.—This may be divided into the *Prophylactic* and the *Curative* treatment. The formation of pus, in acute phlegmonous inflammation, may be *prevented:* more than this, pus after formation may be *absorbed.* I have myself seen this in several instances, and a number of cases were collected in the *Medical Times and Gazette*, for 1858, which proved the possibility, at least, of this occurrence. Nor can this be considered at all unreasonable, if we accept the views of Cohnheim and his followers, who maintain the identity of the pus cell with the white blood corpuscle, and believe that they have actually seen the latter migrating through the capillary walls. Be this as it may, abscesses unquestionably disappear under treatment, though in many cases it is probably the fluid matter only which is absorbed, the solid remaining as a caseous residue, or undergoing cretaceous degeneration. The old humoralistic doctrine looked upon suppuration and abscess as efforts of nature to rid the system of some peccant matter, and hence taught the propriety of promoting and hastening, rather than of endeavoring to prevent, suppuration. I suppose, however, that there are few surgeons at the present day who would not consider the *prophylactic* treatment of abscess at least permissible. The remedies to be employed for this purpose have been already referred to in the chapter on the Treatment of Inflammation: they are such as tend to promote resolution. Sedative and anodyne applications are usually most appropriate; *dry cold*, or *evaporating lotions*, are often useful, the former, especially, in cases in which the integrity of a joint is threatened. *Warm and emollient fomentations*, on the other hand, sometimes answer a better purpose than cold applications; gentle friction with laudanum and olive oil, and the use of cataplasms, will be found most efficient in the prevention of mammary abscess. Finally, it is sometimes possible, as it were, to *stimulate* away an abscess: I have more than once succeeded in dispersing a bubo by the use of a blister, even after pointing had occurred.

Curative Treatment.—The length of time during which abortive measures, if not rapidly successful, may be persevered in, should depend a good deal upon the feelings of the patient. If the pain and febrile disturbance which accompany the formation of an abscess be very great, it will usually be wise to desist from such measures, and strive merely to relieve the patient's sufferings. I am not quite sure that we can often materially hasten the pointing of an abscess by treatment, but we can certainly make the patient more comfortable while the pus is approaching the surface, and the best application for this purpose, in the immense majority of cases, is an emollient poultice. Though an abscess will eventually burst of itself, it is usually better to evacuate its contents artificially—this little operation giving great relief to the patient, and rendering the resulting scar less conspicuous. The *time* at which an abscess should be opened depends on the circumstances of the case: if the pus be deep-seated and bound down by tense fasciæ, the pain being great, an *early* incision, at the most dependent point, should be practised, and will be found to afford the greatest comfort to the patient; if, on the other hand, the abscess be comparatively superficial, and the pain and constitutional disturbance not very intense, it is, I think, better to wait until *decided pointing* has occurred. The reason for this is that, if the incision be made prematurely in another locality, pointing and spontaneous opening may still take place, the surgeon's interference in such a case being afterwards thought by the patient, and not unreasonably, to have been uncalled for.

An acute abscess should only be opened by *incision*, and this is best accomplished, I think, with a straight, narrow, sharp-pointed bistoury. The surgeon, holding the knife in his right hand as a pen, but almost perpendicularly to the surface, with the edge towards himself, fixes the abscess with the thumb and fingers of the left hand, and resting the ring and little finger of the right hand upon the skin, quickly plunges the point of the knife into the cavity of the abscess, and rapidly drawing the blade towards himself, enlarges the puncture to the requisite extent as he withdraws the instrument. The depth to which the knife is to penetrate having been mentally determined beforehand, the instrument is prevented from going too far by the pressure of the fourth and fifth fingers on the cutaneous surface. The incision should be made in a longitudinal direction as regards the part affected. Local anæsthesia has been sometimes used in these cases, but the freezing process is in itself not devoid of pain, while it renders the skin much more difficult of penetration. If the abscess were situated very deeply, there might be some risk of wounding a large vessel in making the opening as above directed, and in such a case it would be better to adopt Hilton's plan, incising the skin and fascia, and then pushing a grooved director through the overlying muscles into the abscess, the opening being dilated by separating the blades of a pair of forceps introduced along the groove of the instrument. A free aperture having been made, the abscess may be allowed to evacuate its contents by the elastic contraction of its own walls; the surgeon may, if necessary, make very gentle pressure with soft sponges on either side of the incision, but all rude handling or squeezing should be strictly avoided. *Hemorrhage* into the cavity of an opened abscess may occur from a vessel accidentally divided, or which subsequently gives way from the relief of pressure upon its walls. The treatment consists in exposure to the air, cold, pressure, or ligation, as in other cases of hemorrhage. After the evacuation of an abscess, poultices may be continued for a few days, until the surrounding inflammation has subsided, when cerate or other simple dressing should be applied to the wound, and the walls of the cavity compressed by means of a bandage or adhesive strips. If, from the size or situation of the abscess, or from any other circumstance, there be a tendency to *bagging* of matter, a *drainage-tube* may be employed, being either simply introduced into the incision by means of a forked probe, or carried seton-like through the cavity, and brought out by a counter-opening. Instead of the ordinary drainage-tube, a flexible metallic probe may be substituted (the pus escaping by its side), or a coil of wire, as recommended by Mr. R. Ellis, or a self-retaining, India-rubber *drainage-anchor*, as suggested by Mr. Davy. The hygienic and constitutional treatment of abscess, and of suppuration generally,

FIG. 189.



Drainage-tube and forked probe.

has already been considered in the chapter on the Treatment of Inflammation.

Chronic or Cold Abscess.—The term chronic abscess is open to objection, as referring etymologically only to time, and being of course merely comparative. A phlegmonous abscess, if deeply seated, may be of slower development than a chronic or cold abscess which is superficial. The term cold abscess is borrowed from the Germans, and is significant, as referring to a prominent symptom in these cases, viz., the absence, in greater or less degree, of the increased temperature and other common signs of inflammation. These abscesses are chiefly met with in connection with diseases of the bones or joints, or of the lymphatic system. They are not attended with much pain, have little or no disposition to point, and sometimes extend widely beneath the skin, or among the planes of muscular tissue. Their development is sometimes very slow, resembling that of phlegmonous abscesses, only with less local and constitutional disturbance, the investing layer of lymph being occasionally so dense as to obscure fluctuation, and give the appearance of a solid tumor; at other times, the patient suddenly discovers in the groin or axilla a large fluctuating swelling, no symptom having been previously manifested to call attention to the part. These abscesses may persist, without undergoing any marked change, for months or even years. The diagnosis must be made with the precautions already pointed out, and often requires the use of the exploring-needle. The pus in these abscesses is usually thin and ill-formed, containing a larger proportion of granules and oil globules, and fewer pus corpuscles, than ordinary "laudable" pus.

The *treatment* of these cases is somewhat different from that appropriate to those of the phlegmonous variety. If the abscess be quite small, it may be simply opened, healing of the cavity being subsequently promoted by the use of some stimulating application, such as the diluted tincture of iodine. In dealing with a larger abscess, it is better to wait until the skin threatens to give way, unless, from the situation of the abscess, it may be necessary to relieve adjacent organs from pressure. With regard to very large abscesses, particularly those which are connected with disease of the spine or bony pelvis, I am decidedly of opinion that it is better, as a rule, to leave them unopened; a patient may carry a psoas or iliac abscess for years with comparatively little annoyance, and maintaining very tolerable health, and yet sink in a very short time after such an abscess has been imprudently evacuated. Besides, there is always the hope that complete or partial absorption may occur, when the patient may remain well, if not permanently, at least for a very long period. If it be determined to open a large chronic or cold abscess, this may be done with the aspirator, or, if preferred, by means of a simple incision made with antiseptic precautions in the manner recommended by Prof. Lister. If an abscess have been freely opened and will not heal, stimulating injections of iodine may be tried, or a seton of oakum or tarred rope may be used (as recommended by Dr. Sayre, in cases of caries), a method which has the additional advantage of insuring drainage of the suppurating cavity. Callender advises hyperdistension of the abscess-sac with carbolized water, a plan which I have myself sometimes adopted with advantage, while J. H. Webb suggests inflation with carbolized air. In all cases of chronic abscess it is necessary to pay great attention to the state of the general health, maintaining the patient's strength by the administration of nutritious food and tonics.

Residual Abscess.—This term has been introduced by Sir James Paget, who proposes to include under it "all abscesses formed in or about the residues of former inflammations." They may occur in the site of previous abscesses which have been partially absorbed, or in the indurations and adhesions left by old inflammation which had not reached the suppurative stage. Residual abscesses are chiefly met with in connection with diseases of the spine, of the bones and joints, and of the lymphatic glands. The *prognosis* is more favorable than that of ordinary chronic abscess, the healing after evacuation being, according to Paget, quicker, and attended with less constitutional disturbance, than that of a primary abscess of the same size and in a similar situation. The *treatment* is that already described as appropriate to chronic abscess arising under other circumstances.

Sinus and Fistula.—These are narrow, and often tortuous, suppurating canals or tubes, left by the incomplete healing of abscesses, or resulting from wounds which have united imperfectly. The term *fistula* is also applied to abnormal communications between external and internal parts (as gastric, aerial, or urethral fistula), or between adjacent mucous canals or cavities (as recto-vesical, or vesico-vaginal fistula). When applied to the condition resulting from an abscess, or ordinary wound, the term fistula should be reserved for those cases in which there are *two* openings (as in a fistula in ano), the more general term, sinus, embracing all those tortuous suppurating tracks, which have but one orifice. Sinuses may be kept from healing by the presence of a foreign body or a spicula of bone, by the passage of secretions, as of saliva or urine, or by the action of adjacent muscles. The *treatment* consists in removing all irritating substances, and in placing the part at rest, by position, bandaging, etc. In a recent case, healing may be promoted by keeping the walls of the sinus in contact by means of compression, while, if the walls of the sinus be callous and indurated, they may be stimulated to greater activity by means of irritating or caustic injections, the tarred seton, or the galvanic cautery. Finally, it may be necessary to freely lay open the sinus through its entire length, by introducing a grooved director and slitting up the superincumbent tissues; the sinus may then be dressed as an open ulcer, and made to heal from the bottom. This mode of treatment is especially indicated when healing is prevented by the action of neighboring muscles, as in cases of fistula in ano, or in the troublesome sinuses which are met with in the groin, in connection with suppurating buboes. It is often a good plan, after laying open a sinus, to wipe its whole track out with the solid stick of nitrate of silver, thus making a superficial slough, and preventing premature reunion of the cut edges.

Diffused Suppuration, though ordinarily occurring in that form of diffuse inflammation of the areolar tissue which is closely analogous to, if not identical with, erysipelas, may, I believe, occur as a sequel of ordinary inflammation in persons in a low state of health, and whose vital powers have been from any circumstance much reduced. It may result from an accidental or other wound, or from the irritation of extravasated urine, but may also occur without any apparent exciting cause. The surface in these cases is but slightly red, the swelling is ill-defined, and rapidly spreads in various directions; there is a feeling of bogginess, rather than of fluctuation, and there is sometimes emphysematous crepitation, caused by the gases developed by the putrefactive process; the patient does not suffer very great pain, but is in a profoundly typhoid condition. The *treatment* consists in making numerous punctures, or small or even large incisions (to relieve tension, and facilitate the exit of pus and sloughs), and in the free administration of stimulants and quinia.

ULCERS.

The process of ulceration and the mode in which ulcers heal by granulation and cicatrization have been considered in a previous chapter, and need not be again referred to. Ulcers have been variously classified by systematic writers, either according to the appearance of the ulcer itself, or according to the constitutional condition of the patient. Thus, we read of healthy, irritable, indolent, weak, inflamed, exuberant, sloughing, varicose, and hemorrhagic ulcers; and again, of eczematous, cold, senile, strumous, scorbutic, gouty, syphilitic, lupous, and cancerous ulcers. It is easy to understand that, in a person disposed to eczema, an ulcer may be seriously complicated by an attack of that disease, and that any treatment, to be successful, must have regard to the eczematous condition, as well as to the ulcer itself. So in a strumous subject, such remedies as iodine and cod-liver oil may be more important than any local treatment. Scorbutic and gouty ulcers require medicines adapted to the scorbutic and gouty diatheses; while it is quite idle to attempt to heal the ulcerated surface of a cancer as long as the cancerous mass itself is allowed to remain. For practical purposes, the classification usually adopted (which has reference to the appearances of the ulcers themselves, when occurring in persons of ordinary good health, and not the subjects of any special morbid diathesis) is convenient and sufficiently satisfactory, it being remembered that there is no specific or essential difference between these various forms of ulcer, but that the ulcerative process is identical in nature under all circumstances.

Simple or Healthy Ulcer.—This may be considered the type of all the other varieties, and that to which they must be brought in order to effect a cure: it is such an ulcer as is seen in a healing burn, or in a superficial wound which is closing by the second intention. The natural tendency of such an ulcer being towards a cure, the only *treatment* necessary is to keep the part from being injured. Water dressing, or a greased rag, with an elevated position of the part, is all that is usually required; if the granulations become exuberant, they should be touched with bluestone or lunar caustic; while if too small and closely set, the resin or carbolic acid cerate may be substituted for the milder applications commonly employed. This variety of ulcer may be met with in any part of the body; those to be next described are most frequently seen in the leg.

Inflamed or Phlegmonous Ulcer.—This variety is usually met with in those of full habit, and may arise from accidental irritation of a simple ulcer. One of the worst cases of this kind that I have ever seen, was in a gentleman who, having a slight excoriation of the tibial region, rode for several hours on horseback, with the stirrup-leather constantly rubbing and chafing the injured part; as a consequence, the whole leg was attacked with phlegmonous inflammation, which obliged the patient to stay in the house, with the foot elevated, for a considerable period. The *treatment* of an inflamed ulcer consists in enforcing rest, with elevation of the part, in the use of soothing applications, either cold or warm, as most agreeable to the patient, and in the administration of laxatives, diaphoretics, etc., as may be indicated by his general condition.

Sloughing Ulcer.—This may be considered as an aggravated form of the last variety, and is usually met with in cachectic or ill-nourished individuals. The *treatment* consists in the administration of opium and of concentrated nutriment, with stimulus if required, and in the local application of anodyne fomentations, such as diluted laudanum. If there be much tendency to spread, the ulcer should be treated as a case of sloughing phagedæna or hospital gangrene. The "electric bath" is recommended by Weisflog.

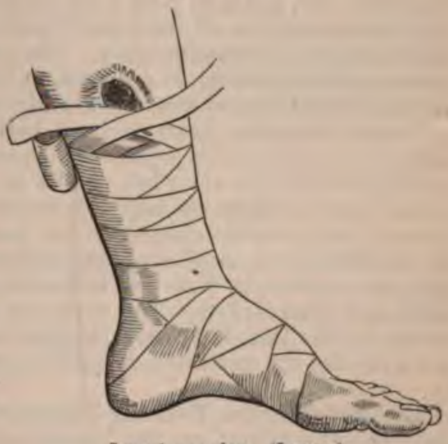
Weak or Œdematous Ulcer.—In this variety the granulations are large, pale, flabby, and apparently distended with serum. They are not unfrequently detached in large masses by sloughing. This form of ulcer may be induced by long-continued application of poultices or of water dressing. I have frequently seen it in cases of neglected gunshot wound. The *treatment* consists in improving the general tone of the patient, and in the local use of stimulating and astringent dressings, such as a solution of sulphate of zinc, or of sulphate of copper, zinc cerate, etc., with moderate support by means of a bandage. Roche, an East Indian surgeon, speaks very highly of applications of the bark of the acacia catechu, so as fairly to tan the ulcer and surrounding skin.

Neuralgic or Irritable Ulcer.—This variety is characterized by the intense pain and hyperæsthesia which accompany it. It usually occurs about the malleoli, or anterior edge of the tibia, and is most frequent in women past the middle age, and who are in a depressed state of health, though I have seen it in young, and otherwise healthy, laboring men. The *treatment* consists in the use of anodyne fomentations, with the occasional application of a solution of nitrate of silver (gr. iv.–x. ad f℥j), as recommended by Skey for painful burns. The general health must at the same time be improved by the administration of tonics, especially quinia, nux vomica, etc. If the pain can be traced to any special nerve, this may be resected, as advised by Mr. Hilton.

Indolent or Callous Ulcer.—This is by far the most common form of ulcer; it occurs usually in those of middle life, and is situated in the lower half of the leg, and more often on the fibular than on the tibial surface. The floor of the ulcer is somewhat concave, with flattened granulations, furnishing a thin and scanty pus. The ulcer is surrounded by an elevated ring of very dense and indurated tissue, which seems to be a provision of nature to prevent the spread of the disease, acting, indeed, as a kind of natural splint to keep the ulcerated surface at rest. As long as this hard ring remains, however, healing will not occur, and hence to depress the edges is the first step in the *treatment* of an indolent ulcer. If the patient can remain in bed, with the foot elevated, a poultice may be applied for two or three days, to soften and relax the tissues, pressure being then applied by means of a few adhesive strips, the positions of which are varied at each dressing, while the edges of the ulcer are stimulated with the solid stick of nitrate of silver. A very good plan of hastening the disappearance of the indurated ring, is to make across it numerous *radiating incisions*, extending about a quarter of an inch into sound tissue, as recommended by Mr. Gay. Sappey's and Syme's method, which consists in the application of a *blister* to the whole ulcerated surface and a zone of the surrounding healthy skin, is occasionally very efficient. Finally, the indurated edges may be trimmed away with the knife, a proceeding which, though apparently heroic, is almost painless, on account of the indolent nature of the sore. As soon as the ulcer has by these means lost its peculiar excavated appearance, it may be dressed with resin cerate, or some similar article, cicatrization being assisted by moderate compression with adhesive strips and bandage. The *sulphuret of carbon* has recently been recommended as a dressing in these cases by Guillaumet and other

French surgeons. In case the skin is very irritable, the disease approaching in character to what is called the eczematous ulcer, wet strips of bandage may be advantageously substituted for those of adhesive plaster. It often happens that patients with indolent ulcers find it impossible to lie by, as above recommended, and, under such circumstances, I know of no better mode of treatment than that introduced by Baynton and Critchett, which consists in closely *strapping* the part, or even the whole limb, with strips of adhesive plaster laid on in an imbricated manner, a firm bandage being then applied over all (Fig. 190); or an India-rubber bandage may be used, as advised by H. Martin. The only constitutional treatment usually required in these cases is such as may be indicated by the patient's general condition. Mr. Skey recommends the administration of opium, which may be given in doses of one grain, night and morning. In the eczematous cases, I have derived advantage from the persistent use of small doses of Fowler's solution.

FIG. 190.

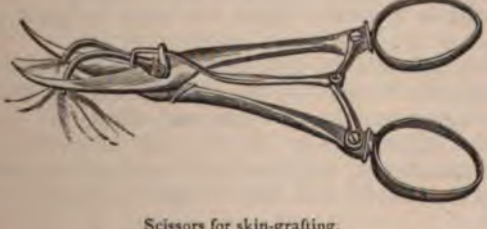


Strapping an ulcer. (LISTON.)

In some cases an ulcer will heal readily up to a certain point, and there will stop, in spite of the most careful dressing—the tension upon the part appearing to be so great that further contraction cannot take place. Under such circumstances, a *longitudinal incision*, as advised by Faure, may be made through the healthy skin on each side of the ulcer, the gaping of the incisions permitting the resumption of the healing process; or *circular incisions*, surrounding the ulcer, as originally suggested by Dolbeau and recently recommended by Nüssbaum, may be substituted. *Plastic operations* have been occasionally practised for the cure of obstinate ulcers of the leg, but, in my experience, have not proved very successful.

It has been suggested by a French surgeon, M. Reverdin, to treat ulcers by the *Transplantation of Cuticle*. The operation consists in applying shavings of the epidermis, or of this with a thin layer of the cutis—the latter plan has been most commonly adopted—to various points of the granulating surface, binding these grafts in position by means of adhesive strips. The

FIG. 191.



Scissors for skin-grafting.

grafts may at first seem to disappear, but in a few days become converted into isolated cicatrices, from which, as from centres, the healing process rapidly spreads. It is essential for the success of the experiment that the granulations should be in a healthy condition, that no fat should be transplanted with the skin, and that the graft should be closely and accurately applied to the granulating surface. Berger advises the preliminary application of a poultice or mustard plaster, so as to increase the vascularity of the skin. This mode of treating ulcers has excited a good deal of attention, and has been tried with more or less successful results at numerous English and American hospitals. Dr. Leale, of New York, employs *warts* instead of ordinary skin. The transplantation of *hairs* has been suggested as a substitute by Dr. Schweninger, a German surgeon. Fischer, of Strasbourg, uses *large* grafts, from an *amputated limb*, in connection with the elastic bandage, while grafts from a *dead body* have been successfully employed by Dr. Girdner.

In some situations, as on the back, between the shoulder-blades, it is very difficult to apply equable pressure by the methods ordinarily employed. Here the application of a *zinc plate*, or disk of *sheet-lead*, cut to fit the ulcer, will often be attended by the happiest results—not, I believe, by the development of any galvanic current, as has been supposed, but simply by acting as an efficient means of applying mechanical compression. The use of a galvanic current is, however, recommended by Spencer Wells, Golding-Bird, and other writers. The virtues of sheet-lead have been recently extolled by Dr. Van Blaeven, a Belgian surgeon, who claims by its use to have effected the restoration of parts carried away by sabre-strokes, etc.

Hemorrhagic and Varicose Ulcers.—Other varieties of ulcer, described by systematic writers, are the hemorrhagic and the varicose. The *Hemorrhagic Ulcer* is one that bleeds from time to time, occasionally existing in connection with the hemorrhagic diathesis, but more often serving as a channel for vicarious menstruation. The treatment, in the latter case, consists in endeavoring to restore the normal flow by means of the remedies ordinarily used for amenorrhœa. The *Varicose Ulcer* is merely an ulcer coexisting with varicose veins. It is commonly taught that the varicose disease precedes and causes the ulcer, and obliteration of the veins is accordingly proposed as the only rational mode of cure. It has been shown, however, I think, by Mr. Gay's researches, that the varicose condition is rather a consequence than a cause of the ulceration, and that hence less active measures will commonly suffice. The *treatment* should vary according to the condition of the ulcer, whether inflamed, irritable, or indolent. Borel-Laurez, a Swiss surgeon, employs a dressing of finely powdered charcoal. Hemorrhage from the bursting of a vein may be checked by position and pressure, or may occasionally require obliteration of the vessel, by the method which will be described when we come to speak of varicose veins in general.

After the cicatrization of an ulcer is completed, a great deal may be done by care and attention to prevent the scar from again giving way. The part should be kept scrupulously clean, and should be protected as much as possible from external injury. If the ulcer be situated on the leg, the patient may advantageously wear an elastic bandage or stocking, to counteract the tendency to gravitation of blood which necessarily exists in that part.

Amputation for Ulcer.—It sometimes happens that an ulcer proves utterly incurable, either from extending completely around the limb, or from deeply involving a subjacent bone or neighboring joint (as in the perforating ulcer which sometimes follows a bunion). In such cases the question of amputation may arise, and the operation under such circumstances would be occasionally justifiable. It must be remembered, however, that amputation, in the lower extremity, is in itself attended with very great risk to life, and that the disease, in the instances mentioned, is often more a source of discomfort than of danger or even positive suffering. Hence the surgeon should hesitate before proposing an operation which is not imperatively required, and which may be followed by the gravest consequences. When amputation is resorted to, it should be done at such a height as to insure the possibility of forming the flaps from perfectly healthy tissues.

Ulcers occurring on Mucous Membranes present the ordinary characters of healthy, weak, or irritable ulcers, as met with in the cutaneous structures. They usually require the free use of stimulating or caustic applications, the best being, probably, the nitrate of silver, which may be employed either in substance or in solution.

Gangrene and Gangrenous Diseases.

The nature and treatment of the ordinary forms of gangrene have already been considered in the chapters on Inflammation, on Wounds in General, on Injuries of Bloodvessels, and on Amputation. There remain to be described certain forms of *Spontaneous Gangrene*, and those affections which are commonly classed together as *Gangrenous Diseases.*

Spontaneous Gangrene may occur at any age, and is due to arrest of the circulation, caused either by disease of the arteries themselves, or by a morbid condition of the circulating fluid. *Inflammation of the arterial coats* may cause gangrene, as may *arterial thrombosis* without inflammation, or *embolism* from the detachment of fibrinous concretions from the valves of the heart; the latter is, I believe, a more frequent occurrence than is usually supposed. Finally, the use of certain articles of food, as of *spurred rye*, has been followed by spontaneous gangrene. This form of gangrene is usually of the *dry* variety, though *moist* gangrene may occur after embolism, when the main trunks which furnish blood to the part are suddenly occluded—the difference probably depending, as remarked by Coote, upon the rapidity with which the death of the part takes place. *Senile Gangrene* (which, as ordinarily seen, may be considered the type of the dry variety of the affection, or *mummification*) is dependent upon calcification of the arterial coats, together with the general loss of tone and enfeebled nutrition which accompany old age. In certain cases, the exciting cause of the disease is some slight irritation, such as the chafing of a shoe, and, under such circumstances, the gangrene approaches somewhat to the ordinary inflammatory form of mortification. More often the disease begins, without apparent cause, as a dark purple or blackish spot, surrounded by a dusky red areola, which spreads with the gangrene and is the seat of intense burning pain, the latter, however, subsiding when the gangrene is complete. The seat of the gangrene is commonly the inner side of the foot, and especially of the great toe, though I have seen a precisely similar condition of affairs in the scrotum, in a patient worn out by a low fever; the fact that this form of gangrene occurs, under such circumstances, among comparatively young persons, shows that the term senile gangrene, though significant, is not strictly accurate. Warning is sometimes given of the approach of this form of gangrene, by the existence of signs of defective circulation, such as numbness, coldness, tingling, and cramps in the calves of the legs. The course of senile gangrene is usually chronic, lasting sometimes for more than a year, and recovery occasionally follows after the separation of the affected part.

Treatment.—This consists in maintaining the general health of the patient, by the use of tonics and by the judicious administration of food and stimulants. Among drugs, *opium* is particularly useful, and may be given in grain doses three or four times in the twenty-four hours. Antispasmodics also may be advantageously used in these cases, especially chloroform (internally) and camphor. The local treatment consists chiefly in keeping the part warm, by wrapping it in cotton-wadding or wool; if there be much fetor, charcoal poultices may be substituted, or cloths wet with a solution of permanganate of potassium. The question of amputation in senile gangrene has already been referred to, at page 92.

Bed-sores.—These may occur in any case in which a patient is confined to bed for a considerable period, simply from the long-continued pressure—just as similar excoriations and sloughs may result from the use of a badly padded splint. The worst forms of bed-sore are, however, seen in patients whose general powers of nutrition are impaired by previous illness (as in typhoid fever), or who, from spinal injury, are totally unable to vary their position. In such cases, it is not infrequent for the slough to extend so deeply as to involve the sacrum, or any other bone that is exposed to pressure, or even, in some instances, to lay open the vertebral canal. The pain attending bed-sores is usually very great, though, in cases of spinal injury, the patient may be unaware of their existence. The formation of bed-sores may commonly be prevented by the use of a water-mattress, or of soft pillows, the parts being kept scrupulously clean, frequently bathed with stimulating and astringent lotions, and protected by the application of collodion, soap-plaster, or adhesive plaster; Prof. Brown-Séquard recommends the alternate application of ice and hot poultices. If a bed-sore have actually formed, the separation of the slough may be hastened by the use of yeast or porter poultices, the ulcer which is left being subsequently dressed with resin cerate, or some similar application; the part must be entirely freed from pressure, and the patient's general health improved by the administration of concentrated food, tonics, and stimulants. In obstinate cases, healing may sometimes be promoted by the application of the galvanic current, as suggested by Crussel, of St. Petersburg, and recommended by Spencer Wells and by Hammond, of New York. Bed-sores may occasionally prove fatal, by involving important structures (as the membranes of the spinal cord), by leading to hemorrhage, by gradually exhausting the patient, or by the induction of pyæmia.

Gangrenous Stomatitis, also called *Gangræna Oris*, *Cancrum Oris*, and *Noma*, is an affection of childhood, coming on after various eruptive fevers, especially measles—a somewhat similar affection sometimes occurring in adults after typhus. Gangrenous stomatitis has been attributed to the abuse of mercury, and this drug, if improperly exhibited, may of course be one source of depression, in addition to the debilitating effects of illness, deprivation of food, etc. That there is, however, any direct causal connection between the use of mercury and this disease, is, I think, at least not proved. The first symptom of gangrenous stomatitis is usually a dusky red swelling of the cheek, which becomes stiff and shining. Careful examination will now show a sloughing ulcer on the inside of the cheek, extending to the adjacent gum, and discharging fetid, ill-formed pus, which, mingled with saliva, constantly dribbles from the mouth. As the diseases progresses, a gangrenous spot appears on the cheek, the whole thickness of the part being finally involved, and perforation of the cheek, with denudation and perhaps necrosis of the alveoli, resulting. The constitutional symptoms are of a typhoid character, coma sometimes supervening before death, which may occur at almost any period of the disease. Dr. Sansom found moving bodies, analogous to bacteria, in the blood of a girl who died from noma, and inoculation of the diseased blood in animals produced septicæmia attended with the formation of similar bodies. The *treatment* consists in everting the cheek (the patient being anæsthetized), and thoroughly cauterizing the whole ulcerated surface with strong nitric acid. One thorough cauterization is usually sufficient, though the case must be watched, and a second or third application made if necessary. In an aggravated case of noma, occurring in a syphilitic child under my care at the Children's Hospital, cauterization with the acid nitrate of mercury, and the internal administration of iodide of potassium, proved very efficient. The mouth should be frequently syringed with detergent and disinfectant washes, such as a solution of the permanganate or chlorate of potassium, or of borax, and the general health sustained by the frequent administration of concentrated food and stimulus. The application of tincture of iodine is recommended by Dr. Miller, of Kansas City, while Popper, of Pesth, advises that the slough should be scraped away, and the parts dressed with creasote. The deformity left after cicatrization may subsequently require a plastic operation for its cure.

Noma Pudendi.—This grave affection, which seems to be confined to female children, is very analogous to the preceding, and usually attacks the mucous or submucous tissues of the generative organs, though, according to Holmes, it sometimes begins in the fold of the groin. The *treatment* consists in early and thorough cauterization, and in the adoption of measures to sustain the patient's strength. Parrot speaks favorably of the local use of iodoform. Death sometimes occurs very suddenly, after the apparent establishment of convalesence.

Hospital Gangrene.—This affection, which has received a great variety of names, such as *Sloughing Phagedæna*, *Pulpy Gangrene*, *Putrid Degeneration*, *Traumatic Typhus*, *Pourriture d'Hôpital*, etc., is occasionally met with as a sporadic disease, but has attracted most attention when prevailing epidemically or endemically in hospitals, especially where large numbers of wounded men are crowded together, as in military hospitals in the neighborhood of a battle-field. It has been studied by a great many writers, among whom may be particularly mentioned, Pouteau, La Motte, Ollivier, Delpech, Legouest, Rollo, Blackadder, Boggie, Hennen, Ballingall, Thomson, Guthrie, and Macleod. It has also been ably investigated by many American surgeons, who had ample opportunities for its study during the late war, and an elaborate monograph on the subject has been contributed by Prof. Joseph Jones, of New Orleans, to the Memoirs of the U. S. Sanitary Commission. The characters of hospital gangrene vary in different epidemics. The majority of observers have found the local to precede the constitutional symptoms, and hence have regarded the disease as a strictly local affection; while in other instances, equally careful observers have found constitutional disturbance, headache, furred tongue, etc., to precede the local changes in the wound by an interval of from one to three days. Hospital gangrene is undoubtedly *contagious*,[1] having been developed by indirect inoculation, as well as through the medium of instruments and sponges; the exceptional cases, in which one of two contiguous wounds, in the same patient, suffered from the disease, while the other escaped, merely prove that in those instances the affection was not auto-inoculable. While, however, hospital gangrene is usually transmitted by contagion, it may probably originate *de novo*, as the result of overcrowding, bad ventilation, etc.

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[1] Dr. W. Thomson examined microscopically the discharges in several cases of hospital gangrene which occurred at Douglas Hospital during the late war, with a view of determining the presence or absence of fungi, which it was supposed might be the source of contagion. "No fungi were found. The discharge consisted of fluid,

Two forms of hospital gangrene may be recognized, but the difference between them is one of degree rather than of kind. For the development of either, the presence of a wound is probably necessary, though this wound may be of the most trivial character, as the sting of an insect, the prick of a lancet, or even the scratch of a finger-nail. A depressed or depraved state of the system does not appear to be at all essential for the development of the disease, though it may very probably aggravate the intensity of the affection when it occurs. The following description, taken from Guthrie, gives a vivid picture of the *worst form* of hospital gangrene. The wound thus attacked "presents a horrible aspect after the first forty-eight hours. The whole surface has become of a dark-red color, of a ragged appearance, with blood partly coagulated, and apparently half putrid, adhering at every point. The edges are everted, the cuticle separating from half to three-quarters of an inch around, with a concentric circle of inflammation extending an inch or two beyond it; the limb is usually swollen for some distance, of a shining white color, and not peculiarly sensible except in spots, the whole of it being perhaps œdematous or pasty. The pain is burning, and unbearable in the part itself, while the extension of the disease, generally in a circular direction, may be marked from hour to hour; so that, in from another twenty-four to forty-eight hours, nearly the whole of the calf of the leg, or the muscles of the buttock, or even of the wall of the abdomen, may disappear, leaving a deep, great hollow, or hiatus, of the most destructive character, exhaling a peculiar stench, which can never be mistaken, and spreading with a rapidity quite awful to contemplate. The great nerves and arteries appear to resist its influence longer than the muscular structures, but these at last yield; the largest nerves are destroyed, and the arteries give way, frequently closing the scene, after repeated hemorrhages, by one which proves the last solace of the unfortunate sufferer. . . . The extension of this disease is, in the first instance, through the medium of the cellular structure of the body. The skin is undermined and falls in; or a painful red, and soon black, patch, or spot, is perceived at some distance from the original mischief, preparatory to the whole becoming one mass of putridity, while the sufferings of the patient are extreme." This worst form of hospital gangrene is, happily, comparatively rare at the present day. In the *milder form*, the whole course of the affection is more chronic, causing less destruction of tissue, and accompanied with comparatively little constitutional disturbance. The general characters of

granular matter, and débris. The connective tissue seemed to have been broken down into unrecognizable granular material. The fibrous tissue was softened and easily teased out, and in the muscular tissue the striated appearance was lost before the fibrous. No evidence of textural growth was found in the discharges, although the 'piled-up' and thickened margins of the ulcers would probably reveal, on examination, a multiplication of the connective tissue corpuscles, as reported in a similar group of cases at Annapolis, Md., by Assistant Surgeon Woodward, U. S. A." (*Am. Journ. of Med. Sciences*, April, 1864, p. 393.) By microscopic examination, Prof. Joseph Jones has discovered numerous animalcules, as well as vegetable organisms, in the gangrenous matter of hospital gangrene, but has been unable to establish any relation between the cause of the disease and the nature and character of these organisms, which have been absent in the most extensive gangrene, when excluded from the atmosphere by sound skin. (See *U. S. Sanitary Commission Memoirs*, (Surgical), vol. ii. p. 266.)

the wound are the same, especially the circular shape, and cup-like excavation or scooped-out appearance of the ulcer. There is less eversion and undermining of the skin, less œdema and pain, and the surface of the wound is covered with a pulpy, ash-colored slough, instead of the putrid clots described in Guthrie's vivid account. The *constitutional symptoms* of hospital gangrene may at first present a somewhat sthenic type, but rapidly change into those of a profoundly typhoid and adynamic condition, the patient indeed presenting much the appearance of one suffering from typhus fever.

The *mortality* from hospital gangrene has varied in different epidemics. During the Peninsular campaign, the death-rate, according to Guthrie, was 20 to 40 per cent., the general average being about 1 death in 3 cases attacked. In the Crimean war, the mortality in uncomplicated cases was much less, while in the experience of our own surgeons, during the late war, the number of deaths was comparatively very small. The *causes of death*, according to Prof. Jones, may be classified as (1) progressive exhaustion, (2) hemorrhage, (3) entrance of air into veins, (4) opening of large joints, (5) formation of bed-sores which subsequently become gangrenous, (6) diarrhœa, (7) subcutaneous disorganization of tissues around the original wound, (8) mortification of internal organs, (9) direct implication of vital parts, (10) pyæmia, (11) phlebitis, (12) profuse suppuration, necrosis, etc.

In the *treatment* of hospital gangrene, it is very important to secure good ventilation and to enforce the utmost cleanliness. Affected patients should be at once segregated (if possible) from others, and, if it were practicable, it would be better that each person attacked should be placed in a separate apartment or tent. It is, indeed, probable that a certain number of the milder cases would get well under simple hygienic treatment, and the risks of exposure are much less than those of overcrowding; as a German surgeon (Prof. Jüngken) has somewhat quaintly put it, "It is, after all, better that the patient should shiver a little in a cold but pure air, than that he should die in a warm but poisoned atmosphere." As it is certain that the disease may be communicated by means of sponges, etc., the greatest precautions should be taken in washing and in dressing wounds. The ward carriage (Fig. 10), or some similar contrivance for using a stream of running water, will, in these cases, be found of great service. The adoption of Lister's antiseptic method is recommended as a prophylactic measure by Nussbaum, of Munich.

The *Local Treatment* of hospital gangrene is now, I believe, almost universally regarded as of the highest importance; many different applications have been employed, varying in severity from the actual cautery down to simple syrup, or buttermilk, and each remedy has proved occasionally successful. The *oil of turpentine* is highly recommended by Prof. Bartholow, and powdered *camphor* by Netter and other French writers. Most surgeons are now agreed as to the propriety of thoroughly cauterizing the entire surface of the wound once, or oftener if necessary; and to insure thorough cauterization, it is necessary first to remove all the adherent slough with forceps and scissors, followed by rough sponging. The varieties of caustic most to be relied upon are, I think, *nitric acid, bromine*, and a strong solution of the *permanganate of potassium*. The latter article is that which I have myself employed, in the proportion of ʒj to f℥j of water, and I have never, as yet, been disappointed in its effect; it is but just, however, to say that I have not had occasion to try it in any cases of the worst form, such as are described by Guthrie. The permanganate has been favorably reported upon by Prof. Jackson, Dr. Hinkle, Dr. Leavitt, and others. *Nitric acid* seems to be generally preferred by British surgeons, and is recommended by Prof. Jones, and by the authors of the "Manual of Military Surgery, prepared for the use of the Confederate States Army," while the *hot iron* seems to be preferred by the French; the latter application would probably be the best in cases attended with hemorrhage. Heiberg, of Christiania, from an extended experience during the Franco-German war, gives a preference to the *chloride of zinc*. *Bromine*, the merits of which were first announced, during our war, by Dr. Goldsmith, has been most favorably reported upon by Drs. Post, Moses, W. Thomson, Herr, and many others, and seems, from the published testimony in its favor, to be, upon the whole, the best caustic which has yet been proposed for these cases. The wound having been previously cleansed, the bromine may be applied undiluted, or in solution with bromide of potassium, by means of a camel's-hair brush, or a sponge or mop, attached to a stick, or by means of a glass pipette or syringe; as the application is very painful, the patient should be first brought under the influence of ether or chloroform. Bromine has also been used in the form of *vapor* (the surface to be acted upon being protected with dry lint, upon which is placed a cloth dipped in pure bromine, and the whole covered with oiled silk), and by means of *hypodermic injection* at the circumference of the sore. (See Dr. Brinton's Report to Surgeon-General, in *Am. Journ. of Med. Sciences*, July, 1863, p. 279.) The bromine acts by producing an eschar, upon the separation of which the wound will usually be found healthy and disposed to heal. Until the slough separates, the wound may be dressed with dilute liq. sodæ chlorinatis, with the permanganate of potassium (ʒj–Oj), or simply with water dressing; the resulting ulcer is, of course, to be treated on general principles.

The *Constitutional Treatment*, if less important than the local, is still not to be neglected. Almost all surgeons, with the exception of Boggie, have agreed in recommending a tonic and stimulant, rather than a depletory, course of treatment. The milder cases require scarcely any medication, attention to the state of the secretions being all that is necessary in many instances. When the typhus condition is more marked, the mineral acids may be used with advantage; the *muriatic acid* of the U. S. Pharmacopœia may be given in five-drop doses, with *opium* and *oil of turpentine*, every three or four hours, as is done in cases of typhoid and typhus fever. *Opium* is, of all single remedies, the most useful in this affection; it may be given quite freely, and a case is reported by Pick, in which gradually increasing quantities of laudanum were administered for fifteen days, the patient taking at the last nearly half an ounce in the twenty-four hours. *Quinia* and *iron* (especially in the form of the muriated tincture) are particularly valuable in the later, though they may be required in the earlier, stages of the disease. The *diet* should consist of nutritious but easily digestible articles of food, such as milk and beef-essence, and on the first manifestation of adynamic symptoms alcoholic stimulants should be freely administered.

Amputation may be occasionally rendered necessary by the occurrence of uncontrollable hemorrhage from a wound which has been attacked by hospital gangrene, or the same measure may be required at a later period, on account of the extensive destruction of tissue, involving, perhaps, bones and joints, as well as the more superficial structures of the part.

It is said that hospital gangrene may occur as an *idiopathic affection*, upon an unbroken surface, the disease then beginning as a vesicle surrounded by a dusky areola, the vesicle ultimately breaking, and leaving a slough, upon the separation of which the characteristic appearances of the affection are manifested: these idiopathic cases are, however, at least, extremely rare, and in those which have been reported, it may be fairly doubted whether some excoriation may not in fact have existed, though so slight as to have escaped observation.

Furuncle or Boil.—This very common affection consists of a localized inflammation of the skin and subcutaneous areolar tissue, almost invariably running on to suppuration, and attended by the formation of a small central slough, which is popularly called the core. Boils may occur at any age, and in any part of the body; they are, however, most common in youth, and are generally seen on the nucha, back, or gluteal region. They are often multiple, frequently come out in successive crops, and occasionally occur epidemically—those who are affected being usually in a depressed state of health. The affection, though very painful and annoying, is not commonly attended with danger. The *treatment* consists in improving the general health by attention to the state of the secretions, and by the administration of tonics, especially *quinia*, if the patient be debilitated. *Yeast* is a favorite domestic remedy. *Arsenic* is sometimes of benefit, given in small doses, and continued for a considerable period. The *liq. potassæ* has been similarly used with advantage, and the celebrated John Hunter, who suffered much from boils, declared that he had cured himself by taking the *carbonate of sodium*. The *local treatment* should vary with the circumstances of the case. If the boil be not very painful, it should be left to open of itself, being poulticed, or simply protected by means of the ceratum saponis, spread upon a piece of soft buckskin or wash-leather. There is some reason to believe that boils are less apt to recur if left to themselves, than if too actively treated. If, however, the patient be in great pain, with much constitutional disturbance, the surgeon should not hesitate to make a free single or crucial incision, the case being afterwards treated as one of abscess. It may be sometimes possible to *abort* a boil by purging, and by the application of tincture of iodine, spirit of camphor (Simon), or mercurial ointment (Roth), or by touching the vesicle which usually marks the point of central slough with lunar caustic, a solution of corrosive sublimate, or the strong aqua ammoniæ. Planat recommends the use of arnica, both as an internal remedy, and, locally, mixed with honey.

Anthrax or Carbuncle.—A carbuncle may be regarded as an aggravated form of boil. It usually begins as a vesicle, surrounded by an indurated dusky areola. The subcutaneous tissue sloughs at an early period, giving the part a peculiar boggy feel, before the skin itself gives way.[1] The skin may slough merely beneath the central vesicle, but, if the carbuncle be large, numerous apertures will be formed, arranged in a cribriform manner. The carbuncle continues to spread, reaching its height in from three to eight days, and accompanied, while it is extending, with great pain and constitutional disturbance. The average diameter of carbuncles is two or three inches, though in some instances they attain a very much larger size. Mr. Paget mentions a case in a man aged eighty, in which the carbuncle measured fourteen by nine inches. Carbuncles are usually met with on the back of the neck or between the shoulders, but may occur in any portion of the body. They are most frequent in the *male* sex and in persons in advanced life. The *causes* of carbuncle are obscure. The affection is usually met with in those who are enfeebled by age, or worn down by overwork or privation, and is sometimes associated with visceral disease, particularly affections of the kidneys, or diabetes. The *prognosis* should always be guarded; though the large majority of cases recover, the disease is always serious. Death may occur from the extension of inflammation to an important organ, as the brain or peritoneum, from visceral complication, from simple exhaustion, or from the development of erysipelas or pyæmia.

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[1] Much light has been thrown upon the pathology of carbuncle by Dr. J. Collins Warren, who describes it as a rapidly spreading, phlegmonous inflammation, or purulent infiltration, of the subcutaneous areolar tissue, its characteristic appearance depending on the anatomical peculiarities of the part affected. (*Columnæ Adiposæ, etc.*, p. 25. Cambridge, 1881.)

Treatment.—If the surgeon be called at an early stage, it may be possible to abort the disease, by opening the central vesicle and applying some caustic agent, such as the nitrate of silver, the Vienna paste, or a strong solution of the permanganate of potassium; or the plan proposed by Dr. Physick might be resorted to, and a blister applied over the whole inflamed surface. It usually happens, however, that the case is first seen when the bogginess and cribriform ulceration show that sloughing of the areolar tissue has already occurred. Under these circumstances, it is commonly advised to make crucial or radiating incisions, deep and free, so as to include the healthy tissue beyond the utmost limits of the disease. Other surgeons make subcutaneous incisions; while others again rely upon the use of caustics, applying these either to the surface, to the incision wounds (when these are made), or around the circumference of the carbuncle, in the form of caustic arrows (*cautérisation en flèches*). It is not proved, however, that any of these methods are effective, either in limiting the extent of the carbuncle, or in shortening its duration. It is possible that incision may, in the early stage of the disease, give relief from pain, but it does so at the cost of considerable loss of blood; while the healing of the incision wounds themselves, imposes an additional tax upon the already overweighted powers of the patient. In most cases it will be found sufficient to cover the carbuncle with a piece of leather or thick kid, spread with lead plaster or soap cerate, a central aperture being left for the escape of the slough. Another plan, which I have found very useful, is to apply pressure, as suggested by O'Ferral, by means of strips of adhesive plaster, beginning at the circumference and laid on concentrically, until all except the central portion is covered. A poultice may be applied over all if there be much pain, or the ulcerated centre of the carbuncle may be simply dressed with wet lint. The extrusion of the slough is much assisted by the concentric pressure (which is not at all painful), and may be further aided by the use of forceps and scissors. Dr. Leitner, of Georgia, accomplishes the same purpose by the application of a cupping-glass. When the slough has come away, the resulting ulcer should be treated upon general principles.

The *constitutional treatment* is equally simple. In the milder cases a little opium may be required as an anodyne, and, if there be constipation, the bowels should be relieved by a mild laxative. Should the tongue be dry and covered with a brownish fur, muriatic acid, in combination with laudanum and oil of turpentine, may be usefully administered. At a later period, quinia and the tinct. ferri chloridi will come into play, while at any stage, if there be delirium or other nervous complication, camphor and ammonia may be given with advantage. The diet should, as a rule, be mild, but nutritious, consisting of such articles as milk, beef-essence, soft-boiled eggs, etc. Alcoholic stimulus, though not necessary in every case, will usually prove a serviceable adjunct to treatment, and is often imperatively demanded, especially in the later stages of the affection.

Facial Carbuncle.—Under this name is described, by British surgeons, a malignant carbunculous affection, which attacks chiefly the lips, and which presents some analogous features to the disease known in France and in this country as malignant pustule.[1] The affection is a very painful one, and frequently proves fatal, through the development of pyæmia. Of 45 cases collected by Dr. Lidell, of New York, only five terminated in recovery. The *treatment* consists in the administration of stimulants, and of large doses of quinia. Local measures are of but secondary importance, but an incision may be required to relieve tension and allow the exit of sloughs.

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[1] M. Reverdin maintains, in an elaborate memoir published in the *Archives Générales de Médecine* for June, July, and August, 1870, that the gravity of carbuncles of the face, and particularly of the lips, is solely due to the frequent occurrence of phle-

Malignant Pustule (**Pustule Maligne, Charbon**).—This affection is usually communicated by inoculation, from direct contact with the blood or other fluids derived from diseased animals, as from horned cattle affected with the *murrain*, or from septic material conveyed by flies, and is said to have occasionally resulted from eating the flesh of such animals, or even to have been transmitted through the medium of the atmosphere. The affection begins a day or two after inoculation, as an itching red spot followed by a vesicle, which bursting leaves a dry brownish eschar. A fresh crop of vesicles next appears around the slough, and the subcutaneous tissue becomes involved, forming a hard swelling to which the French give the name of *Bouton* or *Tumeur Charbonneuse*. The neighboring lymphatic glands often become secondarily inflamed. There is a good deal of fever and of constitutional disturbance, the patient, in unfavorable cases, rapidly sinking into a typhoid state, and dying with the ordinary signs of blood-poisoning.[1] The affection is said by Prof. Gross and other American writers, to be intensely painful, but Bourgeois (one of the latest French authorities on the subject) speaks of the absence of pain as a prominent characteristic. The disease may be distinguished from carbuncle, by the fact of its beginning in the skin and only involving the subcutaneous tissues at a later period, and by the almost complete absence of suppuration. The *treatment* consists in thorough cauterization with caustic potassa, either with or without previous scarification, according to the progress which the disease has made when first seen; Prof. Gross and Dr. Popper recommend total excision. The constitutional treatment consists in the administration of concentrated food and stimulus, with tonics, especially quinia, and the mineral acids. Cézard recommends the use, both internally and externally, of iodine held in solution by means of iodide of potassium, looking upon this drug as a positive antidote to the poison of the disease, while Estradère speaks very favorably of the use of carbolic acid both internally and as a local application. Hypodermic injections of iodine are employed by Chipault, and those of carbolic acid by Trélat.

Other Gangrenous Affections.—Various forms of gangrene are occasionally met with, which cannot be referred to any of the diseases above described. Under the name of *White Gangrene of the Skin*, is described by Quesnay, Brodie, and others, a form of dry gangrene, in which successive patches in various parts of the body, especially the neck, arms, and back, undergo mortification, preserving at first their white color, but becoming subsequently horny and straw-colored, and showing, in the form of red streaks, the capillaries filled with coagulated blood. After the separation of the sloughs, the ulcers heal without difficulty. Quesnay states that this form of gangrene is due either to arterial obstruction, or to compression or paraly-

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bitis, which may cause death by the inflammation spreading to the sinuses of the dura mater, or by the development of pyæmia. He regards the affection as totally distinct from malignant pustule, and recommends early and free incisions. A similar view is held by Dr. Lidell, and has been recently acceded to by Sir James Paget.

[1] Dr. Gerald Yeo and some others believe that the disease is identical with that known to European writers as *Mycosis Intestinalis*, and that the development of an external pustule is not an invariable occurrence.

sis of the nerves of the part. The treatment, according to Brodie, is rather unsatisfactory. In one case, in which the disease was associated with irregular menstruation, the sulphate of copper was given with advantage. Tonics would seem to be usually indicated, and when, as in one of Brodie's cases, and in one quoted by Quesnay from De La Peyronie, the disease succeeds an affection of the skin, arsenic might probably be advantageously employed. Cases of *symmetrical gangrene* are reported by Raynaud, Southey, C. K. Mills, Collins Warren, and other surgeons, and are believed by the last-named writer to be due to some irritation of the vaso-motor nerves, causing permanent spasm of the vessels of the affected part.

A curious case came under my observation at Cuyler Hospital, in which a soldier, noticing a painful pimple or pustule on the back of his hand, applied to the "medical officer of the day," who ordered a flaxseed poultice; the next day the man came to me in great alarm, with a black dry slough upon his hand, exactly the size and the shape of the cataplasm; the eschar, which was quite deep, separated in a few days, and the remaining ulcer healed rapidly under the use of the permanganate solution.

CHAPTER XXI.

ERYSIPELAS.

ERYSIPELAS[1] is an acute febrile disease, attended by a peculiar form of inflammation, which affects the skin, areolar tissue, and mucous or serous membranes. It occurs as an *idiopathic* affection, or as a complication of a wound, being called in the latter case *traumatic* erysipelas. *External* erysipelas, or that which affects the skin and connective tissue, is much more common than the *internal* variety, or that which attacks the mucous and serous membranes. External erysipelas may be divided into the *simple or cutaneous*, the *phlegmonous or cellulo-cutaneous*, and the *cellular or areolar*, which is often spoken of as *diffuse inflammation of the areolar tissue.*

Causes of Erysipelas.—These may be divided into the predisposing and the exciting. Of the *Predisposing Causes*, some relate to the *patient's own condition*, and others to the *circumstances by which he may be surrounded.* Among the former may be enumerated a depressed or debilitated state of the system, resulting from any source, such as chronic visceral disease, especially of the kidneys or liver; diabetes; chronic diarrhœa or dysentery; deprivation of food; neglect of hygienic rules; intemperate habits; overwork, etc. Any sudden source of depression may act as a predisposing cause of erysipelas; thus, in military hospitals, the disease is often seen to follow in the wake of secondary hemorrhage. Among the surrounding circumstances which predispose to erysipelas may be mentioned overcrowding, bad ventilation and sewerage, and the season of the year and the state of the atmosphere; it is notorious that erysipelas is most apt to occur during the cold, damp weather which often prevails about and after the vernal and autumnal equinoxes. The principal *Exciting Causes* of erysipelas are epidemic influence, contagion, and the presence of a wound.

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[1] The usual derivation given for this word is from the Greek ἐρύω (I draw) and πέλας (near); others, however, prefer to derive it from ἐρυθρος (red) and πελός (livid). (See, upon this subject, a note to Mr. DeMorgan's article in *Holmes's Syst. of Surgery*, vol. i. p. 207, and Dr. Stillé's article in the *International Encyclopædia of Surgery*, vol. i. p. 161).

Symptoms of Erysipelas.—1. *Simple or Cutaneous Erysipelas.*—Constitutional disturbance, consisting of rigors, headache, nausea, and fever, may precede the local manifestations for one or two days, though in many instances the patient is not conscious of any marked indisposition, until the appearance of the rash or cutaneous inflammation. In *traumatic* erysipelas, the locality of the rash will be determined by the position of the wound; in the idiopathic variety, though the disease may appear on any part of the body, it is most frequently seen upon the face (especially about the nose, ears, and eyelids), next upon the legs, and more rarely upon the trunk. The eruption appears as a red spot, rapidly spreading into a large patch, with pretty well-defined margins; somewhat elevated; of a bright rosy hue, disappearing under pressure; with a smooth, glazed, shining surface, and attended with a tingling and burning sensation. Except in the mildest cases, vesicles appear on the affected part, containing serum, which at first is clear, but soon becomes turbid, these vesicles eventually drying into brownish scabs. The eruption of simple erysipelas lasts (as a rule) but *four days* in the same part: it may, however, spread to adjacent parts, or may break out in an entirely different region of the body, the affection in these cases constituting respectively the *erysipelas ambulans*, and the *erysipelas erraticum* of the older writers. As the eruption fades, the swelling subsides, the margins lose their definition, and the skin assumes a dry and somewhat wrinkled appearance. The constitutional symptoms are rather aggravated than diminished by the appearance of the eruption, the period of defervescence usually coinciding with that of the decline of the local phenomena.

2. *Phlegmonous, or Cellulo-cutaneous Erysipelas.*—In this form of the affection both the local and general symptoms are more marked. The inflammation involves the subcutaneous connective tissue as well as the skin, the swelling being greater, the color darker, the vesications larger, and the pain more intense than in the simple variety. These signs continue gradually increasing up to the sixth or eighth day, when resolution may commence, or, as is very apt to happen, suppuration and extensive sloughing of the areolar tissue take place; the part, from being hard and tense, now becomes soft and boggy; the skin, at first deeply congested, becomes pale in spots, and then black, and quickly falls into a state of moist gangrene. The constitutional symptoms, which may appear in the beginning to be of a somewhat sthenic character, rapidly degenerate into those of a typhoid type, and death may occur from exhaustion, hectic, diarrhœa, or pyæmia. This form of erysipelas is that which most often occurs in connection with wounds, simply because in such cases the deeper planes of fascia are usually opened, and thus exposed to the influence of the disease.

Under the name of *œdematous erysipelas* is described a modification of the phlegmonous form of the disease, which is chiefly met with in the legs, and about the genital organs of old or feeble persons. Both the local and general symptoms are less marked than in ordinary phlegmonous erysipelas, but there is a considerable effusion of lymph and serum, solid œdema sometimes persisting, and giving the part the appearance of Scleroderma, or Elephantiasis of the Arabs.

3. *Cellular Erysipelas* (*Diffuse Inflammation of the Areolar Tissue*).—The former name is preferable, as there may be a diffuse inflammation of the connective tissue unconnected with the erysipelatous influence (see page

394). In this variety of the affection there is great swelling, tension, and pain, but comparatively little redness. The disease extends rapidly and widely, sometimes from a wound, but at other times beginning at a distance from the point of injury. Suppuration, sometimes attended with emphysematous crackling, occurs about the fourth day, or even earlier, and the skin quickly falls into a state of gangrene. This affection may also attack the deep planes of connective tissue, as in the pelvis or anterior mediastinum. The constitutional symptoms are of a profoundly typhoid type, death sometimes occurring on the second or third day of the disease.

4. *Traumatic Erysipelas* is attended with changes in the condition of the wound itself. The edges become flabby, and the neighboring tissues œdematous. A thin sanious fluid replaces the ordinary healthy pus, the granulations become pale and shining, and the healing process is arrested; recent adhesions may even be broken down and absorbed. A sensation of weight and heat, with great pain, may precede by several hours the development of the characteristic eruption.

5. *Erysipelas of Mucous Membranes.*—The parts most usually affected are the fauces, pharynx, and larynx. Beginning in the fauces, which are swollen and deeply red, the uvula being markedly œdematous, the disease may spread to the larynx, giving rise to a croupy cough, dyspnœa, aphonia, and sometimes death from œdema of the glottis. At a later period fatal consequences may result from extension of the disease to the bronchi or lungs, from sloughing of the part, or from the development of pyæmia. This variety of erysipelas is considered peculiarly contagious. Dr. Goodhart believes certain cases of the affection known as "Surgical Kidney" to be really examples of erysipelas affecting the kidney and urinary tract.

6. *Erysipelas of Serous Membranes.*—This is chiefly met with in the arachnoid and peritoneum, the former being secondarily affected in cases of erysipelas of the scalp, or of injuries in the cranial region, and the latter in cases of injury of the abdomen or pelvis, or after various operations, such as herniotomy, ovariotomy, etc. The symptoms are those of inflammation of the affected parts, with the general evidences of a profoundly typhoid condition.

Diagnosis of Erysipelas.—*Simple* erysipelas may be distinguished from *erythema*, by the fact that the latter occurs in patches of various size, which have no particular tendency to spread, are not elevated, and are unaccompanied by the formation of vesicles. The marked constitutional disturbance also is absent in erythema. From *scarlet fever* the diagnosis may be made by observing the circumscribed character of the erysipelatous eruption, its well-defined margin, the tenseness and glazed appearance of the surface, and the presence of vesicles. There is a peculiar inflammation of the skin which results from contact with the poison sumach (Rhus radicans, Rhus toxicodendron), which is almost identical in appearance with erysipelas; the diagnosis can only be made by the history, and by the invariably mild course of the former affection, which, moreover, is not, I believe, contagious. *Phlegmonous* erysipelas may be distinguished from ordinary inflammation, by the greater extent of surface involved, by the absence of any tendency to point, by the rapidity of its course, and by the asthenic type of the constitutional symptoms. From *phlebitis*, it may be distinguished by the hard, cord-like condition of the vein, and the absence of general redness in that affection: and from *angeioleucitis*, by the fact that in that disease the redness and pain are confined to the course of the lymphatics and their neighboring glands. *Cellular* erysipelas may be distinguished from common diffuse inflammation of the connective tissue, by the even greater rapidity of the course of the former disease, and by the more asthenic type of its general symptoms. Erysipelas of the *fauces* or *larynx*, may be distinguished from *ordinary inflammation* of those parts, by the dusky redness exhibited in the former affection, and by the generally typhoid condition of the patient. Moreover, the manifestation of erysipelas on the cutaneous surface will usually throw light upon the diagnosis. From *diphtheria*, erysipelas of the throat may be distinguished by the greater degree of constitutional disturbance, and by the absence of exudation. Erysipelas of the *arachnoid* or *peritoneum*, can only be distinguished from common *arachnitis* or *peritonitis*, by the primarily typhoid character of the constitutional symptoms in the former affections. The presence of *delirium* is a very frequent accompaniment of erysipelas of any form which affects the scalp, and must not be considered as in itself any evidence of meningeal complication.

Prognosis.—The prognosis, in any case of erysipelas, depends chiefly upon the form which the disease assumes, the locality of the part attacked, and the constitutional condition of the patient. *Simple* erysipelas is usually a mild affection, and, in the large majority of instances, terminates in recovery; if, however, it involve the scalp, or the abdominal wall, there is always a risk of transference to the arachnoid or peritoneum; if the face be affected, it may spread to the fauces or larynx; while, if there be serious visceral disease, especially of the kidney, the slightest attack of erysipelas is likely to prove fatal. Parinaud has collected eight cases, including two observed by himself, in which facial erysipelas has been followed by atrophy of the optic nerve. *Phlegmonous* and *cellular* erysipelas are always very serious affections. In the head, abdomen, and lower extremities, they are particularly apt to prove fatal, extensive sloughing in the latter situation sometimes laying bare the bones and opening the articulations. *Faucial* and *laryngeal* erysipelas sometimes prevail in an epidemic form, and have occasionally, under the name of "black tongue," produced frightful ravages in certain regions of our country. Finally, erysipelas in any form is a serious disease in new-born children, in very old persons, and in women in the puerperal state.

Treatment.—A great deal may be done to *prevent* the development and spread of erysipelas. For this purpose, hospital wards, or the apartments occupied by sick or wounded persons, should be well ventilated and scrupulously clean. All excreta and soiled clothing should be promptly removed, and particular attention should be given to the sewerage; the presence of a foul drain has not seldom proved the starting-point of a local epidemic of erysipelas. As the disease can be unquestionably propagated by direct inoculation, precautions should be taken against the transference of morbid material from one patient to another. The washing of wounds should, if possible, be effected with a stream of running water; if this be impracticable, each patient should, at least, be provided with his own basin and sponge; the dressings should be of such a nature that they can be frequently renewed; they should, therefore, be as simple and as inexpensive as possible. Disinfectants, such as the chlorine preparations, the permanganate of potassium, carbolic acid, or bromine, may be placed in various portions of the room, or may be employed in the dressings. Personal cleanliness on the part of nurses and dressers should be rigidly enforced, and the latter should not be allowed to come directly from the post-mortem or dissection-rooms to engage in their ward duties. The surgeon himself should exercise similar precautions, and, as there is an undoubted connection between erysipelas and certain forms of puerperal fever, should, while attending cases of the former affection, if possible, temporarily decline engaging in obstetric practice. On the first appearance of a case of erysipelas in a surgical ward, the affected patient should be isolated, and disinfectánt measures resorted to, in order to prevent the further spread of the disease.

The *Curative Treatment* of erysipelas may be divided into the *constitutional* and the *local treatment*.

1. *Constitutional Treatment.*—In *simple* or *cutaneous erysipelas*, very little medication is, as a rule, required. If the patient, as is usually the case, be constipated, with a furred tongue, a mercurial purge may be administered. Emetics are often recommended, but, unless it be known that the stomach contains some irritating material, they are, I believe, as unnecessary as they are disagreeable; their reputation is probably derived from their known efficiency in those cases of *erythema* which result directly from the use of certain articles of food. As a cathartic, two or three grains of blue mass may be given, to be followed, in the course of twenty-four hours, by a dose of castor oil or a Seidlitz powder. If there be much heat of skin, neutral mixture may be given, combined with camphor-water if the nervous symptoms are at all prominent. Anorexia will usually indicate the propriety of abandoning solid food, for which milk with lime-water, and beef-essence, may be substituted, in small quantities and at frequent intervals. In most cases, at least as met with in hospitals, a small quantity of alcoholic stimulus may be serviceably directed, but there is seldom occasion to give large quantities, four or five fluidounces of wine, or two or three of brandy, in the course of the day, being usually quite sufficient. Most cases of cutaneous erysipelas will run a satisfactory course under the above simple mode of treatment. If, however, the surgeon wish to do more, there can be no objection to giving the muriated tincture of iron, which is a remedy of undoubted value in the phlegmonous form of the disease, and which may be conveniently combined with the solution of acetate of ammonium. The sulphites and hyposulphites have been rather extensively used in erysipelas, and have, with some surgeons, acquired a reputation, which is, I believe, due more to the natural tendency of this form of the disease to spontaneous recovery, than to any curative virtue of the remedies themselves. In *phlegmonous*, and in *cellular erysipelas*, the patient may be put at once, after attention to the state of his bowels, upon the use of the muriated tincture of iron, which must be believed, from published experience, to exercise a controlling influence over the course of the disease. This remedy, which was first brought prominently to the notice of the profession in 1851, by Dr. G. Hamilton Bell, of Edinburgh, may be given in large doses—as much as twenty or thirty minims—every three or four hours, or even every hour if the urgency of the case require it. Quinia is another drug which may be usefully employed, particularly in the later stages of the disease. Free stimulation may be employed in these cases from the very outset, and as the symptoms assume more and more a typhoid aspect, carbonate of ammonium and oil of turpentine may be properly added to the remedies previously employed. The *complications* which demand special attention, are the supervention of arachnitis, of peritonitis, or of erysipelatous laryngitis. In the case of *arachnitis*, benefit may be expected from free purgation and the use of turpentine enemata. If coma occur under these circumstances, Dr. Copland recommends a full dose of calomel and camphor, followed by an electuary of castor oil and oil of turpentine, placed upon the back of the tongue, and repeated from time to time until purging is begun. Enemata may then be used as adjuvants, and blisters applied to the nucha and thighs, as derivatives. In erysipelatous *peritonitis*, opium is the remedy most to be relied upon. If the disease attack the *air-passages*, the greatest

risk is from œdema of the glottis; here (beside the local measures which will be presently alluded to) a cautious trial may be given to antimony in combination with opium, the latter remedy serving to counteract the spasmodic tendency which almost always exists in laryngeal affections. If the dyspnœa, however, should increase, no time should be lost in resorting to *laryngotomy;* the œdema does not extend below the vocal cords in these cases, and hence this operation is preferable to that of opening the trachea.

2. *Local Treatment.*—The local treatment of erysipelas is almost as important as the constitutional. Very various applications have been used in these cases, and each, at least in simple erysipelas, often with apparent success. It must not be forgotten, however, that, as pointed out by Velpeau, the duration of the eruption in one spot is limited to four days, and that in many instances no other part may become affected. In this, as in many other diseases, a knowledge of the *natural history* of the affection may tend to shake our faith in the curative power of the remedies employed. With regard to local applications in erysipelas, a good general rule is given by Dr. Reynolds, viz., to avoid anything which shall expose the skin to variations of temperature, or which shall interrupt its natural function. Hence cold applications and oily or unctuous substances should not be employed. In *simple or cutaneous erysipelas,* if the affected patch be small, it may be sufficient to keep it well dusted with rice flour, toilet powder, oxide of zinc, or even common wheat flour. If the patch be large, particularly if a limb be the part affected, and generally in hospital practice, it will be better to cover the whole seat of eruption with carded cotton, loosely applied; the cotton excludes the atmosphere and keeps the part in a kind of continuous vapor bath. In cases in which the tension of the part is very great, and which approach, in character, to the phlegmonous form of the disease, warm fomentations, such as chamomile or hop poultices, may be substituted for the simpler applications. Various other articles are recommended by surgical writers, particularly collodion, sulphate of iron, tincture of iodine, nitrate of silver, and, recently, nitrate of lead. Bromine in the form of vapor, applied as described in speaking of hospital gangrene, was somewhat extensively used during our late war, and with alleged advantage. The nitrate of silver, which was first recommended in this affection by Higginbottom, is used in the form of a very strong solution (one part to three), and is applied, after thoroughly cleansing the part, "two or three times on the inflamed surface and beyond it, on the healthy skin, to the extent of two or three inches." Another plan, if an extremity is affected, is to apply the caustic in a broad band, entirely around the limb, a few inches above the seat of inflammation. The spread of the eruption certainly seems, in some cases, to be arrested by the caustic application thus made, but perhaps not oftener than it would have been spontaneously arrested at the same point, had the treatment not been employed. In *phlegmonous erysipelas* more active measures are required. In the early stages benefit may be derived from making numerous *punctures* with the point of a sharp lancet, as advised by Sir R. Dobson; these may be frequently repeated, and act by relieving tension and promoting resolution. If these fail, or if the case be first seen at a later stage, when the brawny feeling of the surface indicates impending suppuration of the subcutaneous areolar tissue, *incisions,* from one to two inches long, and two or three inches apart, should be made over the inflamed surface, in the general direction of the subjacent muscular fibres. These incisions, which should extend through the superficial fascia, were first popularized by Copland Hutchison. They gape pretty widely, owing to the great distension and swelling of the part, their edges presenting a gelatinous appearance from the infiltration of serum and lymph, and soon breaking down into pus mingled with shreds of disinte-

grated tissue. If the hemorrhage from these incisions be troublesome, they should be stuffed with scraped lint until the bleeding has ceased. South advises that the incisions should be arranged in the form of a lozenge, thus , the greatest relief from tension being thus obtained with the least destruction of tissue. At a still later stage, when brawniness has given place to bogginess, showing that sloughing of the subcutaneous tissues has already occurred, free and deep incisions, three or four inches long, may be required, in order to prevent gangrene of the skin, and to afford an exit for sloughs, the separation of which may be hastened by means of forceps and scissors. Warm fomentations should be constantly applied, and antiseptics may be freely used, not only in the dressings, but injected among the tissues by syringing. When the suppuration is very profuse, the fomentation may be omitted, the part being simply covered with lint and charpie, tow, oakum, or carded cotton, the now relaxed tissues being supported by the gentle pressure of a bandage. The abscesses, sinuses, and ulcers which are left after phlegmonous erysipelas, are to be treated on the principles laid down in the last chapter. *Cellular erysipelas* requires the same local treatment as the phlegmonous form of the disease; the incisions should be made even earlier and more freely than in that variety, on account of the greater rapidity with which sloughing of the connective tissue occurs under these circumstances. In certain localities, as in the orbit, the scalp, and the scrotum, early incisions are particularly imperative. In the *orbit*, the incisions are to be made by everting the lids, and pushing the blade of a lancet or bistoury, held flatwise, through the conjunctiva, between the eyeball and orbital walls; in the *scalp*, crucial incisions are the most effective; while in the *scrotum*, a single free incision on either side of the raphe will usually be all that is necessary.

Erysipelatous *arachnitis* may be met by the application of cold to the scalp—the only form of erysipelas, I believe, in which the use of cold is admissible. In erysipelatous *peritonitis*, the whole abdomen should be covered with a warm hop poultice. If erysipelas attack the *fauces*, a strong solution of nitrate of silver, or the muriated tincture of iron, may be freely applied with a sponge or camel's-hair brush; while in erysipelatous *laryngitis*, before resorting to laryngotomy, a trial should be given to free scarification of the glottis, and of as much of the larynx as can be reached, followed by the inhalation of steam, and the free application of a solution of nitrate of silver (ʒj–f℥j). The scarification may be effected with a probe-pointed curved bistoury wrapped with adhesive plaster, or, more conveniently, with an ordinary hernia-knife. Should the patient survive the first risks of the disease, the inevitable sloughing will require the use of detergent gargles (especially such as contain chlorine or bromine), to obviate the fetor and diminish the risk of secondary blood-poisoning.

In a case of *traumatic erysipelas*, if the disease appear to originate directly from the wound, it would be proper to apply to the latter some disinfectant, such as a solution of bromine with bromide of potassium, in hope that the disease might thereby be, if not arrested, at least favorably modified in its course. Hirschberg, of Berlin, recommends in these cases hypodermic injections of a two per cent. solution of carbolic acid.

CHAPTER XXII.

PYÆMIA.

PYÆMIA (in the sense in which the term is used in this work) is a peculiar morbid condition resulting from the absorption of septic material, and usually accompanied by the formation of puriform collections in various tissues and organs of the body.

Virchow, to whose labors we are greatly indebted for our knowledge of the pathology of this disease, distinguishes several forms of blood-poisoning, which are usually classed together as pyæmia, and proposes the names *Ichorrhæmia*, *Septhæmia*, and *Septicæmia*, for that variety which results from the absorption of putrid material from wounds, and is not accompanied by the development of those puriform collections which the older surgeons called "metastatic abscesses," and the formation of which he believes to be invariably due to plugging of the capillary vessels by fragments of disintegrated venous coagula. A similar distinction is made by many of the most eminent French surgeons, who differentiate between what they call *purulent* and *putrid infection*, and Dr. Lidell, one of the more recent American authors on the subject, is disposed to limit the term *Pyæmia* to those cases which are connected with pre-existing *suppuration*, and to apply the term *Septhæmia* to the forms of blood-poisoning which occur in connection with traumatic and hospital gangrene, dissection wounds, etc. Prof. Van Buren, too, teaches that septhæmia is a distinct and well-defined malady, due to the absorption of a definite and peculiar poison. While it is quite possible that further experience and more accurate investigation may, at some future time, enable us to separate and classify different varieties of septic poisoning, to recognize their several sources, and to distinguish the courses which they severally pursue, I cannot but think, with Verneuil, that in the present state of science, it is more practically useful, as it is certainly more convenient, not to aim at these theoretical refinements, but to use the word pyæmia (as has been done in the definition given above) as a generic term, embracing one or more morbid systemic conditions—and to study such condition or conditions as parts of one disease, considering successively its pathological, clinical, and therapeutical relations, with the light afforded by observation and experience.

Nomenclature.—The fact has long been known that patients who have received injuries (especially of the head, or of the long bones), or who have undergone operations, may die from inflammation or suppuration in widely different parts of the body;[1] and various names have been suggested by surgeons, expressive of the theories adopted to account for these phenomena. *Pyæmia* or *Pyohemia* (meaning literally purulent blood) was the name proposed by Piorry, in the early part of this century, and has been used by the large majority of surgical writers; though a misnomer, as far as any pathological significance is concerned, it is perhaps no more objectionable than any other term, and is adopted in this work simply from motives of convenience. Among the other names that have been employed, may be specially mentioned, Phlebitis, Purulent Infection, Purulent Absorption, Purulent or Pyogenic Diathesis, Multiple or Metastatic Abscess, Thrombosis, Surgical Fever, Pyogenic Fever, Suppurative Fever, and Surgical Typhus. These are all more or less objectionable, either as implying an untenable theory, or as referring to some mere incident of the disease. *Surgical Fever* (the name used by the late Sir James Y. Simpson) is perhaps the least objectionable name—even less so than *Pyæmia*—but is not adopted here because it is usually recognized as a synonym for *Inflammatory Fever*, which is quite a different condition.

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[1] See Dr. William Thomson's "Historical Notices of the Occurrence of Inflammatory Affections of the Internal Organs after External Injuries and Surgical Operations" (reprinted from *Edinburgh Med. and Surg. Journal*), Philada., 1840; T. Rose's "Observations, etc.," in *Med.-Chir. Transactions*, vol. xiv.; Dr. G. W. Norris's edition of Fergusson's Surgery; Braidwood, "On Pyæmia, etc.," chap. i., London, 1868; and Blum's Memoir, in *Archives Générales de Médecine*, Nov., 1869, pp. 534–554.

Pathology.—Various pathological theories have been advanced upon the subject of pyæmia, which, though affording an interesting field for study, cannot be entered into within the limits of this work. I shall merely refer very briefly to the views which have most advocates at the present day, and which are—1. The theory which makes pyæmia dependent upon the existence of pus in the blood; 2. That which makes it dependent upon *thrombosis* (the formation of venous clots or *thrombi*), and subsequent *embolism*,[1] or plugging of the capillary vessels with fragments broken off from these clots and called *embola;* and 3. That which makes it dependent on the introduction of a septic material into the blood, and which looks upon the processes of thrombosis and embolism as subsidiary and not absolutely necessary. This seems to me in the present state of our knowledge to be the most plausible theory, and it is that which is here adopted. The theory which accounts for the phenomena of pyæmia by assuming the existence of a *morbid diathesis*, merely puts the difficulty one step further back; it is as hard to account for the diathesis as for the disease which it is supposed to produce. The theory which looks upon the symptoms of pyæmia as reflex phenomena brought about through the agency of the nervous system, is somewhat plausible, but must be rejected as ignoring the facts which have been obtained by clinical observation and dissection, as well as by experiments upon the lower animals.

1. *Pus in the Blood.*—The existence of pus in the blood of pyæmic patients, has been affirmed by a very large number of observers, but strenuously denied by Virchow and others, who declare the supposed pus cells to be merely the white corpuscles of the blood, in increased numbers, and the condition of the blood in these cases to be one of *leucocytosis*, as in the disease called by Virchow, *Leukæmia*, and by Bennett, *Leucocythemia.* Sédillot indeed pointed out certain diagnostic marks as to size, color, etc., by which he believed that the pus cell could be distinguished from the white blood corpuscle, but it is now generally conceded that they are undistinguishable. It may be added that, if Cohnheim's observations are correct—if the white corpuscles and pus cells are really identical, and capable, by means of their amœbiform movements, of wandering through the unbroken capillary walls—the whole question of pus in the blood will have lost much of its significance.

The entrance of pus into the blood has been accounted for in two ways, viz., by the previous existence of *suppurative phlebitis*, and by the occurrence of *direct absorption.*[2]

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[1] From two Greek words, ἐν (in) and βαλλω (I throw or cast).

[2] Piorry's idea that the blood itself could become the seat of inflammation and suppuration, may, in the present state of science, be looked upon as purely chimerical; while the theory which supposes pus to enter the circulation by absorption through the lymphatic system, must be rejected on anatomical grounds, the lymphatic glands acting as filters to prevent the passage of solid particles much smaller than the pus corpuscles. (See *Virchow's Cellular Pathology* (*Chance's edit.*), pp. 184–185.)

Phlebitis was supposed to be the cause of pyæmia by Hunter, Abernethy, Guthrie, Arnott, Cruveilhier, and Liston, and this view has been and perhaps still is adopted by the majority of practical surgeons. The pus is supposed to be formed from the lining membrane of the vein, and thus to enter the circulation, either directly, or by the breaking down of the limiting clot. The objection to this view is that in many cases of pyæmia the veins are not inflamed at all, and that when inflammation does exist, it is secondary and does not involve the lining membrane of the vessel, being what is called by Virchow a *meso-phlebitis* or *peri-phlebitis*. Even when the inner coat is involved in phlebitis, the entrance of inflammatory products into the general circulation would be prevented by the coagulum which in these cases fills the vein.

The theory of *absorption of pus* has received support from the well-attested fact that pyæmia is particularly apt to occur after injuries or operations in parts in which open veins are, from mechanical causes, unable to collapse when cut, or to contract at a subsequent period, as veins ordinarily do, upon the shrinking of their contained clots. On the other hand, it has been repeatedly shown by experiment that (1) the effect of applying healthy pus to blood is simply to induce coagulation; (2) that injection of pus into the blood of healthy animals is not usually followed by fatal results, though repeated injections may produce death; (3) that the injection of the *fluid* part of pus is of itself followed by no evil result; (4) that injections of small quantities of pus act just as injections of various other substances, such as mercury, oil, powdered oxide of zinc, etc., by producing local obstructions (*infarctus*) in the first set of capillaries; and that (5) these obstructions may, in healthy animals, spontaneously disappear, the subjects of the experiments eventually recovering. Hence it is shown that if pus be absorbed into the blood, its action can be only mechanical, and it is very reasonably argued that the pus corpuscle, being at least no larger than the white corpuscle of the blood, is no more likely to produce the obstruction which results in the formation of the "pyæmic patch" or "metastatic abscess," than the white corpuscle itself.[1] Finally, as already remarked, if Cohnheim's views be correct, this whole question will have lost much of its importance.

2. *Thrombosis and Embolism.*—Thrombosis, or the coagulation of blood in the vessels during life, may depend upon a variety of causes, as (1) quiescence or simple retardation of the circulation, (2) the contact of a rough surface, and (3) an alteration of the blood itself, consisting probably in an increase in the proportion of fibrine.[2] *Thrombi* form in the veins in almost every case of injury, or of inflammation of the surrounding tissues, as well as in cases of phlebitis. These venous thrombi or clots increase by aggregation, until they reach the points at which the veins in which they are seated anastomose with their parent trunk; if the force of the circulation in this be sufficiently strong, it may prevent the further increase of the thrombi, but if not, these will continue to enlarge till they project into the main trunk, as shown in the annexed diagram taken from Callender (Fig. 192). A fragment of the projecting part of a thrombus may be broken off and swept into the circulation, passing through the heart and plugging an artery, producing

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[1] It is, however, possible, as remarked by Bristowe, that aggregated masses of pus cells may enter the circulation as pellets or flakes, and prove a mechanical source of embolism.

[2] See Moxon, in Guy's Hosp. Reports, 3d s., vol. xiv. p. 101. According to Schmidt, of Dorpat, fibrine (as such) does not exist in the circulating blood, but is produced by the union of two substances, which he calls *fibrinogen* and *fibrinoplastin*, and coagulation is due to the action of a ferment produced by the disintegration of the white corpuscles.

embolism, and, if the vessel be of sufficient size, perhaps leading to gangrene; just as we have seen in a previous chapter that gangrene may be induced by embolism, from the breaking up of a clot formed in the heart. Under certain circumstances, probably owing to an unhealthy condition of the fibrine, a venous coagulum or thrombus softens and undergoes general disintegration; a large number of small fragments are thus carried into the circulation, and, passing through the heart, plug the first set of *capillaries* (which, if the seat of thrombosis be in the systemic circulation, will of course be the pulmonary), causing thus *capillary embolism*. A few embola may slip through the first, to plug other sets of capillaries, or each point of obstruction may cause fresh thrombosis, and a repetition of the whole process. In the same way capillary embolism may be due to disintegration of cardiac coagula, and to cases of this kind Dr. Wilks has applied the name "*Arterial pyæmia*." The secondary effects of capillary embolism consist essentially in the development of congestion and inflammation in the part deprived of its vascular supply, which often, though not always, goes on to the occurrence of suppuration and gangrene—the embola themselves, in the latter case, breaking down and mingling their *débris* with the products resulting from the disintegration of surrounding tissue. It is probably to this process of thrombosis and capillary embolism, that is due the formation of the large majority of secondary deposits, or "metastatic abscesses," in cases of pyæmia; but that this process is not necessarily present in every case, is shown by the facts that (1) precisely the same set of changes may result from capillary stagnation, produced by the introduction into the circulation of putrid fluids,[1] (2) that the secondary deposits are sometimes absent from the lungs, though present in other viscera (which would be unaccountable on the supposition that they were due solely to mechanical obstruction by solid particles, as in that case these particles, or *embola*, would necessarily block the first set of capillaries),[2] and (3) that in cases of capillary embolism from cardiac disease (*arterial pyæmia*),[3] the course of the affection is very much less acute than is seen in the immense majority of cases of ordinary venous pyæmia, as met with in surgical practice, showing that in the latter there must be something more than the simple processes of thrombosis and embolism. Indeed, Virchow and his followers acknowledge that certain of the phenomena of pyæmia (as ordinarily seen) are not accounted for by these processes, and declare, therefore, that in many cases there is in addition a state of *ichorrhæmia*, due to the absorption of septic material.

FIG. 192.

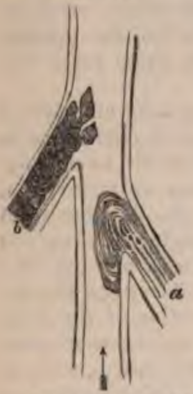

Diagram illustrating processes of thrombosis and embolism; *a*, clot projecting into venous trunk and increasing by aggregation; *b*, clot undergoing disintegration, and allowing fragments to enter the circulation (*embola*). (CALLENDER.)

3. *Absorption of Septic Material.*—We are thus brought to the conclusion that the only theory which is capable of accounting for all the phenomena of pyæmia is that which supposes the pyæmic condition to be induced by the absorption of septic material (usually in a liquid, but possibly sometimes in a gaseous state), which unfits the blood for the processes of healthy nu-

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[1] See Savory, in St. Bartholomew's Hosp. Reports, vol. i. pp. 118–126.

[2] According to O. Weber, however, as quoted by Billroth, certain forms of embola, especially flocculi of pus, may pass the pulmonary capillaries and enter the systemic circulation. Busch explains the occurrence of hepatic embola by the occurrence of retrograde movements of the blood in the vena cava.

[3] See Wilks, in Guy's Hosp. Reports, 3d s., vol. xv. pp. 29–35.

trition, induces capillary stagnation and its consequences, low forms of inflammation, or serous and synovial effusions, and may, and probably does, in most cases, cause venous thrombosis, giving rise to the occurrence of loose and ill-formed coagula, which, rapidly undergoing disintegration, cause capillary embolism, and thus produce the secondary deposits, or metastatic abscesses, which are so common in this affection.

Morbid Anatomy.—Under this head I shall describe very briefly the chief post-mortem appearances observed in fatal cases of pyæmia. In cases which prove very rapidly fatal (the *septicémie foudroyante* of Verneuil and his followers), time is not afforded for these changes, and, under such circumstances, the post-mortem appearances are almost negative. The characteristic lesions of this affection consist in local congestion, extravasation, and inflammation, with gangrene, and occasionally true suppuration. Small fibrinous plugs (embola) can sometimes be detected in the smaller vessels leading to the affected part, but more often the microscope reveals only a mass of granular matter, lymph and blood cells, fibrils, oil globules, and *débris* of tissue. If true pus exist, it is the result of suppuration occurring secondarily *around*, and not *in*, the pyæmic patch.

Lungs.—*Pyæmic patches*, or, as they were formerly called, *metastatic abscesses*, are most often seen in the lungs, and (according to Callender) in the left, more frequently than in the right. They vary in size from that of a small pea to an inch or more in diameter. They may occupy any portion of the lung, but are most frequent at the posterior part, and are usually present in considerable numbers. They are hard and resisting to the touch, and when cut open present varying appearances, according to the stage which has been reached, their color being reddish-black, brown, pale buff, or yellowish-gray. They are always surrounded by a well-marked vascular zone. When near the pleural surface, they often cause pleurisy, marked by the formation of lymph, in patches, and by the effusion of turbid serum. Beside presenting these pyæmic patches, the lungs are often diffusely congested, or even inflamed.

Liver.—The liver is most often affected, next to the lungs. The progress of pyæmic patches in this organ seems to be more rapid than in the pulmonary tissues, so that the puriform appearance is very quickly developed; a circumstance which accounts for the fact that "metastatic abscesses" are often observed in the liver, when the morbid changes in the lungs have escaped attention.

Other Viscera.—The *Kidneys*, *Spleen*, *Heart*, *Brain*, *Bowels*, *Testes*, *Prostate*, *Eye*, *etc.*, may all be similarly affected, and probably in the order named, as regards frequency. Dr. Bristowe, indeed, considers that the kidneys are more often affected in pyæmia than the liver. The spleen may be much enlarged, even when not the seat of the characteristic pyæmic patches. The *Peritoneum* is not unfrequently locally inflamed, as the result of pyæmic deposits in the various abdominal viscera.

Joints.—The articulations are often swollen and inflamed, containing a turbid puriform fluid (sometimes, probably, true pus), the synovial structures being deeply congested, and the cartilages eroded.

Bones.—The bones are probably occasionally, but very rarely, the seat of secondary pyæmic changes. On the other hand, pyæmia very often originates in inflammatory affections of bone, especially (as we shall see hereafter) in osteo-myelitis.

Muscles and Areolar Tissue.—Pyæmic deposits are not unfrequently met with among the muscular layers of the thoracic or abdominal walls, or in the neighborhood of joints, and, according to Bristowe, occasionally in the tongue. True suppuration may occur under these circumstances, resulting in the rapid formation of abscesses of large size.

External Surface.—The skin presents a yellowish appearance, and is sometimes absolutely jaundiced. Open wounds are found dry, the granulations having often completely disappeared, and the surface being pale and glazed, or occasionally covered with a grayish slough.

Lymphatics.—The lymphatics in the neighborhood of a wound are often inflamed, and abscesses form in the adjoining lymphatic glands. It is doubtless to the irritation of the lymphatic system, that is due the increased number of white corpuscles sometimes observed in the blood in pyæmic cases. It was this phenomenon (which Virchow calls leucocytosis) which first suggested to Piorry the name of Pyæmia.

Bloodvessels.—*Phlebitis* is a very frequent accompaniment of pyæmia. The veins are thickened and somewhat contracted, containing clots, which are usually firm and adherent above, but softened below, and disintegrated into a puriform fluid, which was formerly supposed to be actually pus. The *arteries* are, I believe, not affected in cases of ordinary pyæmia, except that the smallest branches may be sometimes the seat of embolism. Dr. Wilks believes that in some cases of what he calls arterial pyæmia, the pathological condition is one of arterial thrombosis *in sitû*, rather than of embolism from softening cardiac clots. The *capillaries* in various parts of the body are occasionally seen to be plugged by embola; but, as already indicated, this condition is, in most instances, inferred, rather than demonstrated.

Blood.—The blood often presents no abnormal appearances, though in other cases it contains an unusually large proportion of white blood corpuscles (*leucocytosis*). Its coagulability is usually diminished, and it is commonly found fluid or imperfectly clotted. This want of coagulability is one cause of the liability to capillary oozing or parenchymatous hemorrhage, which is often observed in cases of pyæmia, a tendency which is probably assisted, as pointed out by Stromeyer, by the venous obstruction due to thrombosis, and which is still further aided by the complication of leucocytosis, when present—capillary bleeding being, as is well known, a frequent occurrence in cases of leukæmia or leucocythemia. Small organisms (*bacteria*) are commonly found in the blood of pyæmic patients, but have not been proved to have causal connection with the occurrence of the disease.

Causes of Pyæmia.—As *Predisposing Causes* of pyæmia may be mentioned previous illness, visceral disease (especially of the kidneys or liver), exhaustion, loss of blood, prolonged shock, over-crowding (especially of suppurating cases), a scorbutic condition, the puerperal state, certain diseases—such as erysipelas, hospital gangrene, carbuncle, osteomyelitis, etc.—and, finally, the presence of an open wound. The *Exciting Cause*, according to the pathological view adopted in this chapter, is the absorption of a septic material, usually in the form of a liquid, from a wound or ulcer, but, in some cases, from the alimentary or other mucous membrane; or, possibly, in the form of a gas, by the medium of the lungs. It is asserted by many writers, that pyæmia never occurs except in connection with the existence of an open wound. There are, however, cases on record, in which pyæmic symptoms have not appeared until after the cicatrization of a wound, and Savory declares that pyæmia not only occurs without the previous existence of any wound, "but sometimes, so far as the most careful and complete examination can show, without any previous suppuration or any other local mischief whatever."[1] Dr. Savreux-Lachappelle[2] has collected a number of cases of so-called *idiopathic* or *essential pyæmia*, and has shown that in most of these instances *exposure to cold* has been the apparent cause of the affection. There is, moreover, reason to believe that, in some cases, the pyæmic poison is generated in the secretion which lubricates mucous membranes. Hence, while in the immense majority of cases we may safely assume that the *materies morbi* of pyæmia is developed in the fluids of a wound or ulcer, we are forced to believe it possible that the septic material which gives rise to the disease, may originate *de novo* in the system, as the result of extraneous influences. With regard to the question of the *contagiousness*[1] of pyæmia, we must speak with a certain degree of hesitation; in the ordinary sense of the term it is certainly not contagious—not in the same sense, that is, as typhus fever or measles. Pyæmia may, undoubtedly, be inoculated by careless use of sponges, etc., or may possibly be transmitted by proximity alone; but in either case the septic material must be generated in the fluids of the wound or ulcer of the person about to be affected, before infection can take place. Even in the rare cases in which the peculiar septic matter of pyæmia is supposed to have been absorbed in a gaseous form through the lungs, it is possible that the sole office of the morbid substance derived from without has been to produce a change in the fluids of the part, the true pyæmic poison being there developed, and causing infection as a secondary consequence; just as in other instances it is probable that the pyæmic poison is generated in the secretions of the alimentary or genito-urinary mucous membranes.

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[1] St. Bartholomew's Hosp. Reports, vol. iii. p. 77.

[2] See notice in Archives Gén. de Médecine, October, 1869, pp. 488–491.

Symptoms of Pyæmia.—The first symptom of pyæmia, at least in surgical cases, is almost always a sensation of cold, with usually a decided *rigor* or *chill*. These chills are subsequently repeated, at irregular intervals, and are commonly followed by profuse and exhausting *diaphoresis*, the hot stage which is generally observed after malarial chills being, in cases of pyæmia, absent, or but slightly marked. The greatest elevation of *temperature* coincides with the period of rigor, the thermometer not often going above 104°, though occasionally, if the chill be very severe, reaching 106° or 107°, or, according to Billroth, even 108°, Fahr. The irregular variations of temperature, which range over 10° or 11° Fahr., are considered by Wagstaffe of diagnostic value. During the sweating stage the temperature rapidly falls. According to Ringer and Le Gros Clark, the elevation of temperature begins before the development of the chill, and the former author believes that the occurrence of the rigor may be predicted by thermometrical observation. The *pulse rate* is rarely below 90, usually ranging from 100 to 130, and (according to Bristowe) occasionally reaching 200. The *respiration* is usually hurried and anxious, ranging from 40 to 50 in the minute, and sometimes even more. The breath is said to have a *hay-like* odor, though I cannot say that I have myself observed this symptom. There is commonly *cough*, with expectoration of viscid or of blood-stained sputa, and physical examination reveals the signs of *pulmonary congestion*, with *pneumonia* (lobular or lobar) and *pleurisy*. *Pericarditis* may be present, but its signs are often masked by the respiratory sounds. The *countenance* is flushed, the *skin* presents a dusky, sallow, somewhat jaundiced hue, and is often marked with sudamina, which, being surrounded by a zone of congestion, have been mistaken for the spots of typhus, or of typhoid fever. At a later stage, a pustular eruption, resembling that of smallpox, has been observed. Petechiæ, ecchymoses, and localized gangrene, occur in some cases. The *tongue* is usually furred; there is commonly complete *anorexia;* often *nausea* and *vomiting;* and usually *diar-*

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[1] See in connection with this subject a paper by Dr. J. Burdon Sanderson, in Med.-Chir. Trans., vol. lvi. p. 345.

rhœa. The *urine* is frequently albuminous. The patient is often *delirious*, particularly at night, or may be profoundly *soporose*, though rousing up and answering intelligently when addressed. *Intense pain* often accompanies the formation of the secondary deposits or inflammations, particularly when these are superficial, as in connection with the joints. If there be an *open wound*, it will probably become dry and glazed, all reparative action ceasing; occasionally, however, healthy granulations continue to be formed almost to the end of the case, or, on the other hand, absolute sloughing may occur. Profuse *capillary hemorrhage* may tend still further to weaken the patient. Before death the symptoms assume a profoundly typhoid character: sordes accumulate upon the lips and gums; the tongue becomes dry and brown, and sometimes cracked and bleeding; subsultus tendinum and carphologia, with low, muttering delirium, mark the profound implication of the nervous system, and the patient may die comatose, or apparently from pure exhaustion.

Diagnosis.—The diagnosis of pyæmia can usually be made by carefully observing the history and the symptoms of the case. From *Inflammatory Fever*, from *Hectic*, and from *Typhoid Fever*, pyæmia can usually be distinguished by its greater fluctuations of temperature and higher thermometrical range, and by its repeated rigors, occurring at irregular intervals. From inflammatory fever it further differs, in that the former affection commonly yields on the occurrence of suppuration. The irregularity of the chills, together with the absence, or at least the want of prominence, of the hot stage, will prove of diagnostic value as regards *Intermittent* and *Remittent Fevers*. From *Rheumatism*,[1] and especially from what is called *Rheumatoid Arthritis*, the diagnosis is often extremely difficult, particularly if the pyæmia assume a chronic form. Under such circumstances, the surgeon must rely chiefly upon the history of the case, the condition of the wound (if there be one), the degree of prostration, and the tendency to suppuration—which occurs as a rule in pyæmic joint affections, and only exceptionally in those of a rheumatic character. The secondary local manifestations of pyæmia may be readily confounded with other diseases. Thus an idiopathic pneumonia, occurring after an amputation, might be mistaken for the lung complication of pyæmia, and a similar error might be made with regard to other organs. I was once asked to see a patient in whom marked brain symptoms, with general febrile disturbance, had followed traumatic erysipelas supervening upon an excision of the elbow. The case had been supposed to be one of pyæmia, but I diagnosticated tuberculous meningitis, chiefly from observing the intense headache, with screaming, the absence of prostration, and the existence of the *tache cérébrale*, or red mark produced by lightly drawing the finger-nail over the surface of the chest or abdomen. The correctness of this opinion was subsequently demonstrated by an autopsy.

Prognosis.—The prognosis of pyæmia is always unfavorable, and in an acute form the disease is almost invariably fatal. The subacute and chronic varieties, however, are less hopeless, and, in any case, the longer the patient can be kept alive, the better is the prospect of ultimate recovery. I have myself seen at least five cases of pyæmia terminate favorably—three after partial excision of the radius or ulna, one after partial amputation of the hand, and one after amputation at the knee—but in none of the five did the affection assume a very acute form. The *duration* of the disease varies greatly in different cases. Occasionally, in what the French call the *foudroyante* form of pyæmia, death may occur within a day or two of the first rigor. From four or five days to a week is the usual duration of acute cases, though life may be prolonged for ten days, a fortnight, or even longer. In cases which recover, the patient usually goes through a long illness, and may be left permanently crippled by secondary implication of the articulations. The occurrence of abscesses in superficial parts, where they can be evacuated, is looked upon as rather a favorable omen; and I have sometimes thought that the diarrhœa, in these cases, appeared to act as a derivative in relieving the internal viscera.

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[1] There is reason to believe that the affections known as *Gonorrhœal Rheumatism*, *Urethral Rheumatism*, *Urethral* or *Genital Fever*, etc., are actually mild forms of pyæmia, resulting from the development of septic material in the secretion of the genito-urinary mucous membrane.

Treatment.—As *Prophylactic Measures*, all those precautions should be adopted, which were discussed in speaking of operations in general, and of erysipelas, hospital gangrene, etc., diseases which are often followed by pyæmia. As every patient with a suppurating wound is liable to this affection, the surgeon should use every effort to obtain primary union, or at least cicatrization without any unnecessary delay; at the same time he must take care to secure free drainage from the wound, lest, in his zeal for early healing, he cause purulent and other fluids to be pent up and confined, thus defeating the very object which he is seeking to promote.

The various predisposing causes of pyæmia should as far as possible be obviated, for we know of no way by which the development of the poison can be certainly prevented, nor by which it can be hindered from producing its deleterious effects. The administration of various drugs has been proposed, with the idea that they would exercise a prophylactic influence: the permanganate of potassium, and more particularly the sulphites and hyposulphites (the latter agents on the recommendation of Polli, of Milan), have been somewhat extensively employed, but have not, I believe, fulfilled the expectations of those who have used them, and the same may be said of carbolic acid and the carbolates. Labat, of Bordeaux, has advised the internal exhibition of ergotine, which he believes acts by increasing the plasticity of the blood; the evidence adduced in its favor, is, however, but negative, as is that in favor of the tincture of aconite, recommended as a prophylactic in these cases by Chassaignac.

Curative Treatment.—The treatment of this disease must be conducted on those principles which guide the surgeon in the management of other affections of a typhoid character: *there is no specific for pyæmia.* If the patient be at first constipated, with a deeply furred tongue, it may be proper to give a small dose of blue mass, followed by magnesia or other mild cathartic. Under such treatment the tongue will often clean off, to become, however, again furred in a short time, as the case progresses. Quinia is, I believe, more valuable than any other single drug, in the treatment of pyæmia: it may be given in doses of four or five grains, every three or four hours. Guérin, who has great confidence in this medicine, uses very large doses—giving as much as a drachm in twenty-four hours. Socin, of Basle, used still larger quantities—90 to 105 grains in the twenty-four hours—with success during the late Franco-Prussian war. Legouest and Bouillaud think the cinchona bark itself a preferable agent to quinia. Iron may be combined with the quinia in the form of the muriated tincture, or, which Braidwood prefers, the citrate of iron and quinia may be substituted. The oil of turpentine is, I think, a useful stimulant in these cases; it may be given with muriatic acid, in an emulsion, a few drops of laudanum being added to each dose, if there be a tendency to undue purging. As diarrhœa, however, appears in some cases to be a means adopted by nature to eliminate the poison, it should not be hastily checked, unless so profuse as to be in itself a cause of exhaustion. Opium may be required to relieve pain or restlessness, and in such cases may be given in any form that convenience may indicate. Carbonate of ammonium may often be employed with advantage; if the pulmonary complications be prominent, it may be properly combined with syrup of senega, as a stimulating expectorant. Transfusion of blood is recommended by Marcacci. In all cases the patient should be supplied with abundance of light but nutritious food, given in small quantities and at short intervals, and alcohol, in the form of wine or spirit, must be likewise administered very freely; Socin, of Basle, in connection with the huge doses of quinia above referred to, gave his patients three bottles of wine *per diem*. In the worst case of pyæmia in which I have ever known recovery to follow, the patient got every hour, day and night, a tablespoonful of whiskey, with six of milk and four of lime-water, for more than a week; his anorexia was complete, with constant nausea, and retching at the very idea of food, and it was only by his taking this combination regularly, as medicine, that life was sustained.

With regard to *Local Measures*, beyond care as to the cleanliness of wounds, and the use of disinfectants, I do not know of any plan worthy of much confidence. The application of the actual cautery in the course of the superficial veins (if these be inflamed), or to the wound itself, has been highly recommended by several writers. Legouest advises that the wound should be washed with the perchloride of iron. Nitric acid and various other caustic agents have been likewise employed, but the evidence is not very satisfactory as to any benefit derived from their use. Ligation of the principal vein of the limb has been employed with alleged benefit in cases recorded by Krausold and others. Probably the most rational plan is to be satisfied with keeping the wound clean and lightly dressed; and diluted alcohol, or weak solutions of the permanganate of potassium, or of carbolic acid, are probably better applications, in these cases, than poultices or other more cumbrous forms of dressing. Free drainage from the wound should be secured by position or otherwise, and if abscesses form in accessible situations, they should be opened at an early period, and their cavities afterwards frequently washed out with disinfectant fluids.

Under the course of treatment above described, a certain number of the milder cases of pyæmia may be conducted to a favorable termination, and, occasionally, a patient more severely attacked, may be snatched as it were from the very jaws of death; but there is reason to fear that the large majority of pyæmic cases will prove fatal in spite of all our care and attention, and that this frightful affection will continue to deserve the name which has been not inaptly bestowed upon it, of the "Bane of Operative Surgery."

CHAPTER XXIII.

DIATHETIC DISEASES.

STRUMA (INCLUDING TUBERCLE AND SCROFULA); RICKETS.

BESIDE the affections to the consideration of which this chapter is devoted, there are two diseases which have claims to be regarded as of a diathetic or constitutional nature, viz., Cancer and Hereditary Syphilis. The former will be described when we come to speak of malignant tumors, and the latter under the head of Venereal Diseases.

STRUMA.

The terms *Struma*, *Scrofula*, and *Tubercle* have been very variously applied by pathologists. Some look upon them as indentical, while others use struma as a general term embracing both the others; some subdivide scrofula into two varieties, the sanguine and phlegmatic, and ignore the independent nature of tubercle, while others recognize the two forms of scrofula, and consider tubercle as a distinct affection; some, again, recognize but one form of scrofula (the phlegmatic), and apply the term tubercle to the sanguine variety, while still others are disposed to doubt the existence of any form of scrofula, apart from a syphilitic taint. It will thus be seen that the use of these words is necessarily attended with a good deal of confusion, and it would be well if we could dispense with them all, and adopt others which might be universally adopted as having a definite signification.

Under the general term of *struma*, surgeons (whatever be their theoretical views) practically recognize, as justly remarked by Holmes, three classes of cases, viz., (1) those in which there is evidence of the existence of tubercle, (2) those in which there is no tubercle, but in which the ordinary processes of inflammation, etc., present modifications which can only be accounted for on the supposition of the antecedent existence of some morbid condition or diathesis, and (3) cases which present, in reality, nothing more than the constitutional effects of long-continued local disease. Under the latter head come a large proportion of cases of chronic bone and joint disease, which are commonly though incorrectly called strumous. Rejecting then entirely the third class, we have the cases in which tubercle exists, and which may be properly called tuberculous, and those in which there is evidently a morbid diathesis (not tuberculous), to which we may conveniently, if not very scientifically, apply the term scrofulous.

Tubercle or Tuberculosis.—I shall not enter into any discussion as to the nature and origin of tubercle, a question which belongs more properly to the domain of general pathology than to that of practical surgery, and upon which the leading authorities of the present day are still not agreed.[1] It is usually said that tubercle occurs under two forms, the gray or miliary tubercle, and the yellow tubercle. The latter is probably in many instances not tubercle at all, but the result of caseous or cheesy degeneration (*tyrosis*) of pus, cancerous deposits, or other pathological formations; in other cases, however, the yellow is the result of caseous degeneration of the miliary tubercle.

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[1] See review of Waldenburg's "Tuberculosis, Pulmonary Consumption, and Scrofula," by Dr. J. C. Reeve, in *Am. Journ. Med. Sciences*, Jan. 1870, and Mr. Butlin's article in *International Encyclopædia of Surgery*, vol. i. pp. 235–239.

Gray or miliary tubercles occur as small granular masses, about the size of millet-seeds, rather hard, semi-translucent, and presenting a glistening cartilaginous appearance. Under the microscope, these masses show a homogeneous or slightly fibrous stroma, containing cells with one or more nuclei, free nuclei, granules, etc. In the so-called yellow tubercle, which usually occurs in larger masses, the cells have a withered appearance, and the granular matter is in larger proportion, and mixed with oil globules.

The following scale of the frequency of tubercle, in various textures and organs, is taken from Rokitansky: lungs, intestinal canal, lymphatic glands (particularly the abdominal and bronchial), larynx, serous membranes (especially the peritoneum and pleura), pia mater, brain, spleen, kidneys, liver, bones and periosteum, uterus and tubes, testicles with prostate and seminal vesicles, spinal cord, and striated muscles. The favorite *primary* seats of tubercle, after the lungs and lymphatic glands, are the urinary and sexual organs, and the bones. Tubercles are only met with in vascular parts (hence not in cartilage), and are often deposited in the external coats (adventitia) of the smaller vessels, a circumstance which may account for their frequent appearance in the choroid coat of the eye, where they have been recognized during life by means of the ophthalmoscope (see Waldenburg, and Reeve, *loc. cit.*, p. 148). Tubercle may become indurated and calcified (obsolete), but usually tends to softening, disintegration, and liquefaction; the fact of its absorption is not established, though its possibility is admitted by both Rokitansky and Virchow.

The *causes*, *symptoms*, *course*, and *general treatment* of tuberculosis are described in every work on the Practice of Medicine, and need not therefore be referred to here: it may be stated, however, that there are strong grounds for believing that, among the sources of depression which act as predisposing causes of the development of tubercle, *long-continued suppuration*[1] is one which must not be ignored. Hence an additional reason in the treatment of surgical cases, for paying attention to the constitutional condition of the patient, and for preventing, if possible, deterioration of the general health. With regard to the question of *operative interference* in tuberculous cases, no general rule can be given. The prognosis of an amputation or excision for tuberculous disease, is undoubtedly less favorable than that of a similar operation for scrofulous or simple chronic inflammation. If there be evidence of tuberculosis of internal organs, any operation should as a rule be avoided; the only exceptions are—(1) when it appears that the visceral disease is caused by the external affection, and when therefore there would be reason to hope that by removing the latter the progress of the former might be checked, and (2) when the patient's suffering from the external disease is so great, that the operation is called for simply for the relief of pain.

Scrofula or Scrofulosis, as the term is here used, denotes a constitutional condition or diathesis, which imparts a peculiar character to the processes of inflammation and ulceration, and which is particularly marked by a tendency to cheesy degeneration in the lymphatic glands, and to a low form of inflammation of the bones and joints.

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[1] Dr. Burdon Sanderson looks upon tuberculous deposits as closely analogous to the "metastatic abscesses" of pyæmia. The theory of the "inflammatory origin of tubercle" is supported by the results of experiments upon the lower animals.

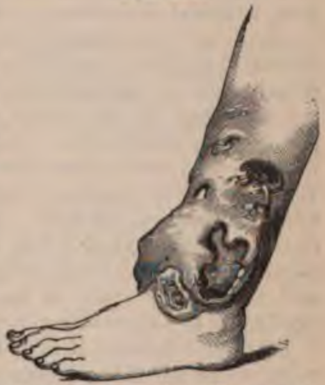
Many writers speak of a *scrofulous temperament*, and describe certain peculiarities of feature and complexion, as characteristic of the scrofulous diathesis. Mr. Erichsen describes two forms, the fair and the dark, and subdivides each of these into two varieties, the fine and the coarse: Sir Wm. Jenner, on the other hand, regards the fine varieties (which constitute what is usually called the *sanguine* temperament) as belonging to the tuberculous diathesis, and limits the term scrofulous to the temperament commonly recognized as the *phlegmatic*. Although, however, there are doubtless many cases of tuberculosis met with among persons of a sanguine temperament, with delicate features, clear complexions, and highly developed nervous systems, there are perhaps almost as many among those whose temperament would be unhesitatingly pronounced phlegmatic, so that, as Holmes justly remarks, the exceptions to the rule are almost as numerous as its exemplifications. It is, indeed, questionable whether there be any temperament that can be positively declared to predispose to either scrofula or tubercle, or, on the other hand, any temperament in which either or both of these diseases may not under favoring circumstances be developed.

The scrofulous diathesis may be inherited, or may be acquired by subjection to various sources of depression, such as bad or insufficient food, intemperance, bad ventilation, exposure, mental anxiety, etc. Even when not manifesting itself in the form of any particular malady, it is usually characterized by weakness and irritability of the digestive system, by a feeble circulation, and by a state of general anæmia.

Manifestations of Scrofula.—The manifestations of scrofula which chiefly come under the notice of the surgeon, are scrofulous inflammation and ulceration, affecting the skin and mucous membranes, scrofulous disease of the bones and joints, and cheesy degeneration of the lymphatic glands.

1. *Skin.*—Various cutaneous eruptions have been considered as scrofulous, but upon somewhat questionable grounds; there can be no doubt, however, that cutaneous ulcers are modified in their appearance and course by the scrofulous diathesis, the tissues around the ulcers in these cases being greatly thickened and infiltrated with serum, the granulations large and feeble, and the cicatrices, when formed, thin, weak, and liable to re-ulcerate (Fig. 193).

FIG. 193.



Scrofulous ulcer of leg. (ERICHSEN.)

2. *Mucous Membranes.*—The mucous membranes, under the influence of the scrofulous diathesis, become thickened and irritable. The secretions may be thin and acrid, or sometimes mixed with pus. In the eyes there may be granular conjunctivitis, with perhaps haziness or ulceration of the cornea, and in the Schneiderian membrane, hypertrophy, giving rise to obstructed breathing and snuffling; the antrum may swell, discharging purulent mucus into the nostrils; the tonsils are not unfrequently enlarged, and the voice rendered husky by relaxation or thickening of the laryngeal mucous membrane; diarrhœa is frequent, and cystitis, urethritis, and leucorrhœa may each in turn be due to the scrofulous diathesis.

3. *Bones and Joints.*—The scrofulous diathesis seems to render the bones and joints peculiarly disposed to unhealthy and destructive forms of inflammation. Thus an accident, which occurring to a healthy person would be

quite trivial, may in one of a scrofulous diathesis be productive of the most serious consequences. I have known a fall on the ice, which would ordinarily have caused a mere bruise, to give rise, in a scrofulous child, to acute osteomyelitis of the humerus, with pyarthrosis of both elbow and shoulder, amputation at the scapulo-humeral articulation being eventually required. Under the influence of scrofulosis, inflammation of bone is apt to assume the form of caries, or of caries with limited necrosis (*caries necrotica*), while in the joints are found the various affections popularly called "white swellings," gelatiniform degeneration of the synovial membranes, ulceration of cartilages, etc.

4. *Lymphatic Glands.*—Perhaps the most unequivocal manifestation of scrofula is the tendency which it induces to cheesy degeneration (*tyrosis*) of the lymphatic glands. Indeed, Waldenburg, as quoted by Reeve (*loc. cit.*, p. 154), defines scrofula as "a constitutional anomaly in which the lymphatic glands have an abnormal tendency to disease, and possess a local disposition to undergo cheesy degeneration." Glandular enlargement, particularly in the cervical and submaxillary regions, is very frequently observed in cases of scrofulosis, and, under very slight irritation, suppuration is apt to occur in the neighboring areolar tissue, the glands themselves breaking down, and mingling the caseous products of their degeneration with the surrounding pus. The abscesses thus formed are extremely indolent, not healing permanently until all the affected glandular structure has been removed, and cicatrizing finally with depressed and disfiguring scars.

5. *Other Organs* are occasionally though less frequently affected by scrofula. Among those which are most important, from a surgical point of view, may be enumerated the mammary gland and the testis.

Treatment of Scrofula.—The treatment of scrofulosis should consist more in attention to hygienic rules than in the use of medicines. Good air, good food, habitual cleanliness, sufficiently warm clothing, and protection from exposure or other sources of depression, are of the highest importance. Special attention should be given to the digestive functions, and either constipation or diarrhœa should be obviated, rather, however, by regulating the diet than by the use of drugs. Among medicines, certain tonics are particularly serviceable. Cod-liver oil probably deserves the first place, the most useful articles after it being iron, quinia, and the preparations of iodine. The syrup of the iodide of iron is a very good combination, particularly for administration to children. These tonics should not, however, be given indiscriminately, and, as a rule, not while there is evidence of marked intestinal derangement. Alcoholic stimulants must be used with great moderation, and the lighter wines, or malt liquors, such as lager beer, are commonly preferable to the stronger forms of stimulus.

By *local treatment*, it is doubtful whether much can be accomplished. A most important rule, and one which should be constantly borne in mind, is to take care lest by our treatment we convert this, which is essentially a chronic affection, into one which is acute. Hence in many instances the best thing for the surgeon to do is to let the part alone, merely protecting it from external injury. In other cases more active measures may be employed, though always with care and watchfulness. *Scrofulous ulcers* may be dressed with slightly stimulating or astringent applications, and the livid, unhealthy-looking edges may be touched with the actual cautery, or even removed with the knife. *Lymphatic enlargements* should be protected by means of soap plasters, or, if very indolent, may be submitted to gentle frictions, with moderate pressure, and the use of mildly discutient lotions. Even if abscesses form, it is better, I think, to delay opening them, as long as there is the slightest chance of absorption and spontaneous disappearance. If an opening be inevitable, it is probably better made with the knife than left to nature, as the resulting scar will be less disfiguring. Any sinuses that are left may be encouraged to heal by stimulating injections, or by means of a seton. Repeated tappings with the hypodermic syringe, or exploring needle, are recommended by Lawson Tait and Crocq, in the treatment of suppurating glands in the neck.

With regard to *operations* in scrofulous cases, no rule of universal application can be laid down. I am decidedly of the opinion that, in the immense majority of instances, enlarged cervical glands should not be interfered with; apart from the fact that the disease in such a case commonly extends much deeper than it appears to, these operations almost always come into the category of operations of expediency, and, as such, are only exceptionally justifiable. With regard to operations for scrofulous bone and joint disease, the question is more doubtful. As a rule, it may be stated that no operation should be performed while a reasonable hope remains that a cure can be effected by expectant treatment; if, however, the powers of nature should be manifestly incompetent for the task, or if (as is often the case among patients of the poorer classes) the time which would probably be required for a natural cure be an important consideration, operative measures may be properly resorted to, and will often be followed by the most gratifying results. Excision is of course preferable to amputation, when the circumstances of the case permit a choice.

RICKETS.

Rickets or Rachitis is a constitutional disease, occurring almost exclusively in childhood, and characterized by a peculiar lesion of the osseous system, and by a tendency to the so-called amyloid or albuminoid degeneration of certain viscera, especially the spleen and liver.

Causes.—Rickets may possibly in some cases be inherited, but is, at least, much more frequently acquired,[1] and usually results from mal-nutrition, or from other sources of constitutional depression to which children may be exposed. According to Heitzmann, rickets can be artificially produced by the continued administration of lactic acid.

Morbid Anatomy.—The most characteristic manifestation of rickets is seen in the skeleton, and affects the long bones as well as those of the head, chest, and pelvis. The bony changes consist essentially in increased cell-growth, with deficiency of earthy matter. The epiphyseal cartilages (cartilages of conjunction) become enlarged, giving what is often called the "double-jointed" appearance observed in these cases. The periosteum is also greatly thickened, while the osseous shaft itself undergoes softening, its lacunæ being much enlarged, and filled with red, pulpy granulations. Under the influence of muscular action, or other mechanical causes, the bones undergo modifications of shape, giving rise sometimes to great deformity; if the child has begun to walk before the development of rickets, these changes will probably be most marked in the lower extremities. The cranial bones are often much thickened, giving a massive appearance to the head; in other cases they are abnormally thin, or even perforated (*craniotabes*), the pericranium and dura mater seeming to be in contact; the anterior fontanelle remains open longer than in health. Circumscribed swellings may occur in the frontal and parietal bones, as pointed out by R. W. Taylor, and may be mistaken for syphilitic nodes. These swellings may subsequently undergo resolution, or may remain as permanent deformities. The ribs bend at their junction with the costal cartilages, allowing the sternum to project, and causing the so-called "pigeon-breasted" deformity. In some cases the enlargement of the sternal extremities of the ribs gives the appearance of a deep gutter on either side of the breast-bone. The spine is occasionally the seat of lateral, but more often of antero-posterior curvature, the backward curve being in the dorsal, and the forward in the cervical and lumbar regions. The pelvis often becomes very oblique, in consequence of the deformity of the lower extremities, and of the "lordosis" or anterior curvature of the lumbar spine; and serious complications may thus arise in after-life, in the process of parturition, or in operations on the pelvic organs.

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[1] This subject is well discussed by Parry, in an excellent paper in Amer. Journal of Med. Sciences, for April, 1872.

Symptoms and Course.—In the earliest stages of rickets, there are disorder of the digestive system and other evidences of mal-nutrition, but nothing that can be considered distinctive. Teething is delayed, and often accomplished with difficulty. The child sleeps badly, and is restless; sweats profusely about the head, and constantly kicks off the bed-clothes. The muscular system is weak, and the patient, if he has already begun to walk, soon loses both the power and the disposition to do so. The urine is abundant, and usually loaded with phosphates. As the disease advances, a curious state of muscular hyperæsthesia is often observed, either voluntary motion or the touch of another being attended with acute pain, and the child, as a consequence, maintaining an almost fixed position, and appearing listless and indisposed to even the slightest exertion. There is a tendency to bronchial and pulmonary inflammation, laryngismus stridulus, and cerebral irritation with convulsions. Fever is often, but by no means always, present; the appetite is capricious or wanting, and the fecal evacuations (whether there be or be not diarrhœa) are ill-formed and offensive. The liver and spleen are often enlarged, and sometimes albuminous or amyloid, in the latter stages of the affection, while the bony deformities, which have been described, frequently persist even after the entire restoration of the general health and strength. Intelligence is diminished during the existence of the disease, but the mental powers are usually completely restored with bodily convalescence.

Diagnosis and Prognosis.—There are no symptoms by which, in its earliest stage, rickets can be distinguished from the other diathetic diseases which we have considered. In any case in which dentition is much delayed, or in which difficulty in walking is observed, the surgeon may suspect rachitis, and, by careful attention to the symptoms above described, will usually be able to recognize it if present. When the characteristic osseous changes have begun, the nature of the affection can scarcely be mistaken. The *prognosis* of rickets, if the disease be not too far advanced, is usually favorable; as justly observed by Hillier, however, mortuary records recognize the secondary affections which complicate rickets, while the primary condition which renders those complications fatal, is itself ignored. As a rule, it may be said that the earlier the disease appears, the less is the chance of recovery, while even in the most favorable cases the affection may last for several years.

Treatment.—The hygienic management of rickets is of the greatest importance; if the disease occur during the first six or eight months of life, and the mother's milk be found either scanty or of bad quality, a healthy wet-nurse should be procured, or the natural food supplemented or replaced by fresh cow's milk, diluted with lime-water (1 part to 4); *dog's milk* is preferred by Bernard. After a time, beef-tea may be made to alternate with the milk, and wine or brandy may be given in quantities adapted to the patient's age. The child should be warmly clothed, and kept as much as possible in the open air, and at night in a well-ventilated apartment. Warm or cold sponging, or sea-bathing, will often prove of great service. If the digestive system be much disordered, a few doses of mercury with chalk, or some similar combination, may be given, but the remedies of greatest importance are tonics, especially cod-liver oil, iron, quinia, and nux-vomica. The cod-liver oil is probably the most valuable, and may be given in gradually increasing doses as the child is able to assimilate it. Dr. Withers, an Irish surgeon, recommends the sulpho-carbolate of lime. Some difference of opinion exists as to whether mechanical appliances should be used to obviate deformity in these cases. In the most acute form of rachitis, when, in the vivid language of Sir William Jenner, the child "is indeed fighting the battle of life, . . . striving with all the energy it has to keep in constant action every one of its muscles of inspiration," the use of splints and bandages would be doubtless an unnecessary annoyance; again, after the stage of bony consolidation has come on, splints can be of no use, and would do harm by impeding the natural motions; but, while the bones are yet soft and yielding, a great deal may be often accomplished by the use of light apparatus, to prevent if not to remedy deformity. For the lower extremities, simple wooden splints may be used, and may be made to project below the feet, so as to prevent the child from standing or walking; while for the spine, various forms of apparatus, such as will be described in speaking of spinal curvature, may be employed. When excessive deformity of the long bones persists in after-life, it may occasionally be proper to endeavor to remedy it by cutting through the bone with saw or chisel (osteotomy), or even by removing, subperiosteally, a wedge-shaped portion. Operations of this kind have been successfully resorted to by Little, Marsh, Billroth, Guérin, Bœckel, Bradley, and other surgeons.

CHAPTER XXIV.

VENEREAL DISEASES.

GONORRHŒA AND CHANCROID.

THE term *Venereal Disease* is applied to certain affections which are usually acquired in sexual intercourse. There are three separate diseases which are properly described as venereal, which until within a comparatively recent period were all confused together, and the distinction between two of which is even at the present time not recognized by a large number of surgeons. These diseases are Gonorrhœa, Chancroid, and Syphilis. The first two are strictly local, while the latter is a constitutional affection. The non-identity of gonorrhœa with the other venereal diseases, though pointed out by Balfour, B. Bell, Hernandez, and others, was not clearly established until the publication of Ricord's treatise, in 1838, while the diversity of chancroid and syphilis—first clearly shown by Bassereau, in 1852—is even now denied by a good many surgeons, and is practically ignored by a still larger number.

GONORRHŒA.

Gonorrhœa, Blennorrhagia, or, as it is vulgarly called, *Clap*, is a virulent, contagious, muco-purulent inflammation, affecting the mucous membranes. It is chiefly seen in the generative organs, being usually met with in the male urethra and in the vulvo-vaginal canal—the glans penis and lining membrane of the prepuce, the uterus, and the female urethra, being less often involved. It also occurs in the conjunctiva, and is said to have been seen in the rectum, nose, mouth, and umbilicus.

Causes.—The most frequent cause of gonorrhœa is unquestionably direct contact with the muco-pus derived from a person similarly affected. It may, however, arise from contact with the vaginal secretions in cases of leucorrhœa, from contact with the menstrual fluid, or even, possibly, from intercourse between healthy persons, if coitus be violent, prolonged, or attended with unusual excitement. In the immense majority of instances gonorrhœa is acquired in sexual congress, and hence is observed in the mucous membranes of the urino-genitary apparatus. Ophthalmic gonorrhœa—or, as it is usually called, gonorrhœal conjunctivitis—is caused by transference of the contagious secretion from the private parts to the eye, by the patient's hand, or possibly by means of dirty towels, etc., while the rarer forms of rectal, nasal, umbilical, and buccal gonorrhœa may be similarly produced, or may be due to practices the nature of which it is not necessary to specify.

Gonorrhœa of Male Urethra.—I shall first describe, under this heading, the course, symptoms, and appropriate treatment of an ordinary gonorrhœal attack, considering subsequently the various complications which may arise, and the modifications of treatment required by each. The first symptoms are usually manifested from one to five days after exposure to contagion, though the disease is occasionally not observed until a week, or even a fortnight, after the infecting coitus. The patient first notices an uncomfortable stinging or tickling sensation (which the French call *picotement*) at the urinary meatus, and, on examining the part, observes the lips of the urethra slightly swollen and reddened, and moistened with a small quantity of viscid secretion. This fluid gradually increases in amount, and from being, as at first, colorless, soon becomes milky or yellowish-white in appearance, and under the microscope is found to consist of mucus mingled with pus. In this, which is called the *first or incubative stage*, the inflammation is confined to the anterior portion of the urethra, and especially the part known as the fossa navicularis, but in the course of two or three days spreads backwards, and becomes much more intense. The discharge is now quite profuse, of a greenish-yellow color, somewhat thicker than at first, and occasionally streaked with blood; the urethra is tense and painful, and the whole penis—but particularly the glans—red and turgid. Urination is frequent, and attended with a good deal of irritation, or scalding (*chaude-pisse*), and the stream is lessened in size, on account of the swelling of the mucous membrane. If the bulbous portion of the urethra be affected, the perineum is tense and painful; while, if the prostatic portion be involved, the anus feels hot, and as if stuffed with a foreign body. If the inflammation run very high, there may be a good deal of general febrile disturbance. This, the *second or acute stage* of gonorrhœa, lasts from one to three weeks, and then gradually subsides into the *third or chronic stage*, which, when long persistent, receives the name of *Gleet* or *Blennorrhœa*. In the third stage, the discharge diminishes in quantity and gradually loses its purulent character, while the intensity of all the symptoms, and especially of the scalding in urination, becomes markedly lessened. The inflammation lasts longest in the posterior portion of the urethra, and matter can be sometimes made to flow by pressure from behind forwards applied to the perineum, when the anterior portion of the canal has apparently quite resumed its normal condition. Gonorrhœa, in most cases, tends to a spontaneous cure, lasting on an average from six to twelve weeks; but occasionally an intractable gleet may persist for many months, or even years.

Under the name of *Dry Clap* have been described cases of gonorrhœa, in which it is said that all the symptoms were well marked, with the single exception that at no time was there any discharge. I am disposed to think, with Bumstead, that in these cases closer observation, with perhaps examination of the urine, would have shown that some muco-pus was actually present. I do not believe that gonorrhœa can exist without discharge, though it is very possible that the amount of discharge may sometimes be so slight as readily to escape detection.

Diagnosis.—I do not believe that it is possible to distinguish, with absolute certainty, gonorrhœa caused by impure coitus, from other forms of muco-purulent urethritis. It is usually said that the diagnosis can be made by observing the greater virulence of the blennorrhagic affection, and, unquestionably, ordinary inflammation of the urethra rarely attains the intensity which is common in cases of gonorrhœa. Very intense muco-purulent urethritis may, however, be caused by the contact of the acrid vaginal secretions in cases of leucorrhœa, or by the contact of the menstrual fluid; and it is believed by many of the very highest authorities, that genuine gonorrhœa is thus not unfrequently produced. Whether this be admitted or not; whether, that is, we believe in the existence of any special gonorrhœal virus, or consider, as has been done in the preceding pages, that gonorrhœa is merely a peculiarly virulent form of ordinary inflammation, we must grant that it is often quite impossible to fix upon the exact source of the disease, in any particular instance; and hence the practical inference, that the surgeon should, in cases the history of which is not clear, exercise great caution in expressing an opinion, of the correctness of which he cannot be absolutely sure, and which may not only cause great unhappiness, but may perhaps involve some innocent person in unmerited disgrace and blame. Fortunately the question is one of theoretical rather than of practical interest, for the treatment of muco-purulent urethritis is the same, no matter whence its origin. In its chronic stage, the diagnosis of gonorrhœa presents still greater difficulty, for a thin, gleety, urethral discharge may come from very various sources of irritation—being indeed a not unfrequent attendant upon the gouty, strumous, and scorbutic diatheses, or a mere secondary affection resulting from diseases of neighboring parts, such as the rectum or prostate gland. The form of urethral discharge which, as will be seen hereafter, is a manifestation of secondary syphilis, can usually be recognized by its grayish-white color, and by the absence of inflammatory symptoms.

Prognosis.—Though in the large majority of instances, gonorrhœa proves a perfectly tractable affection, and passes off without any disagreeable consequences, cases are occasionally met with in which a troublesome gleet proves utterly rebellious to treatment, remaining as the starting-point for an acute attack of the disease, which may be provoked by any sexual excess, indulgence in intoxicating beverages, or even imprudence of diet; in other cases gonorrhœal inflammation gives rise to organic stricture of the urethra, or may cause serious and even fatal disease of the bladder and kidneys.

Treatment.—The treatment of gonorrhœa is principally of a local character. If the patient be seen in the *first stage*, before the inflammation has reached its point of greatest intensity, what is called the *abortive treatment* may be properly employed. The plan which I am in the habit of following is to direct urethral injections of a solution of nitrate of silver (gr. ¼–f℥j). Of this preparation from two to four fluidrachms should be carefully injected into the urethra, three, four, or five times a day, the patient taking the precaution to wash out his urethra by urination ten or fifteen minutes before each injection. The injections are best made with a small hard-rubber syringe, which is in every way preferable to the common glass syringe usually sold for the purpose. In using the syringe, the patient should gently introduce its beak as far as it will go into the urethra, the lips of which are then closely pressed against the instrument with the thumb and fingers of the left hand, while the piston is slowly driven down by the forefinger of the right hand, which holds the syringe. By this method the escape of fluid is prevented, and the whole amount is introduced into the canal; there is no risk of the injection entering the bladder, and even should it do so, no harm would result, for it would be instantly decomposed by the salts of the urine. Two syringefuls may be used on each occasion of injection, as the effect of the first is always to some extent neutralized by the mucus which lines the urethra. The first effect of these injections is apparently to aggravate the disease, the discharge becoming purulent and profuse; in the course of a day or two, however, it again becomes thin and watery, and perhaps streaked with blood, while the concomitant symptoms lessen in intensity; the injections may now be used less frequently, or altogether discontinued, and very often no further treatment will be required. If, however, the discharge do not cease in a few days, mildly astringent injections may be used to complete the cure. No constitutional treatment is required during this stage, except a saline cathartic if there be constipation. The patient should be kept as quiet as possible, and upon rather low diet. The recumbent position should be maintained (confinement to bed is desirable, but often impracticable), and all sources of excitement, particularly of the sexual organs, carefully avoided. Some surgeons use, in this stage, very strong injections of nitrate of silver (gr. x to xx–f℥j), and a very rapid cure may thus occasionally be obtained. The treatment should in such a case be conducted by the surgeon himself, one injection being all that is usually employed. The plan which I have recommended is, I think, safer, and equally satisfactory.

In the *second* or *acute stage* of gonorrhœa, the precautions already referred to, as to rest and quiet, are of the highest importance. After the bowels have been freely moved, the patient should be put at once upon the use of alkaline and diluent diuretics—the following combination being perhaps as suitable as any other: ℞. Sodii bicarbonat. ʒj; Spt. æth. nitr. f℥ss; Infus. lini comp. Oj. M. A wineglassful of this mixture, which is not disagreeable to the taste, may be taken every two or three hours—the whole pint being consumed during the day. The glans penis and prepuce should be gently freed from the discharge as often as it accumulates, and much comfort may be derived from the local application of water as hot as can be borne. Injections are not usually available during the first twenty-four hours of the acute stage, but if the meatus be not so much inflamed as to render the use of the syringe painful, anodynes[1] may be thus employed with advantage—or even simple demulcents, such as thin starch—or local sedatives, such as the subnitrate of bismuth. Küchenmeister, of Dresden, employs diluted lime-water. As soon as the first intensity of this stage has passed by, injections become again the most important remedies, the best articles being probably the sulphate or acetate of zinc, the acetate of lead, and, as the disease becomes chronic, the sulphate of copper, or tannic acid. The following formulæ will usually be found satisfactory: ℞. Zinci sulphat., Plumbi acetat., āā ℈ij; Morphiæ sulphat. gr. i–ij; Aquæ f℥viij. M.—℞. Cupri sulphat. gr. xij; Vin. opii fʒj; Aquæ rosæ f℥vj. M.—℞. Ac. tannici ʒj; Glycerinæ f℥j; Aquæ f℥v. M. Dr. Sée, of Paris, speaks very favorably of injections of silicate of sodium (gr. v to xv–f℥j), while Dr: Boyland, of Baltimore, recommends salicylic acid (gr. v–f℥j), and Radha Nauth Roy, an East Indian surgeon, the sulphate of quinia (gr. ij–f℥j). Dr. S. Eldridge advises the local use of ergotin. During this stage the patient should keep the testes constantly supported with a well-fitting suspensory bandage, a precaution which seems to lessen the risk of the inflammation spreading to the epididymis.

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[1] The following formula is given by Bumstead: ℞. Extract. opii ℈j; Glycerinæ f℥j; Aquæ f℥iij. M.

During the *third stage*, injections should be continued, and advantage may be sometimes derived from the use of *deep injections*, applied through a double catheter, or simply by using a syringe with a long nozzle. Special forms of apparatus for this purpose have been devised by various surgeons, among others by Reliquet, Morgan, Dick, Durham, Windsor, Bumstead, Bigelow, and Hewson. Harrison advises *irrigation* or *douching* of the urethra with a solution of sulpho-carbolate of zinc. In some cases, a slight discharge will persist long after the subsidence of all inflammatory symptoms; for these chronic gleets, a very strong solution of tannin (ʒj–f℥j) will sometimes be found useful; it may be used as an injection, or the preparation described in the last edition of the U. S. Dispensatory as the *glycerate of tannic acid* may be applied on a sponge, through the tube of an *endoscope*. This instrument, which will be again referred to, is occasionally useful in obstinate cases of gleet, by enabling the surgeon to ascertain the exact point to which local medication should be applied. It will usually be found that the continuance of the discharge is due to persistence of inflammation in some of the mucous crypts or follicles which line the urethra, or to the existence of a slight stricture; in the latter case, the occasional passage of a full-sized bougie will be found of service. During the later stages of gonorrhœa, the general condition of the patient often requires the use of tonics, with good food, and malt liquors, or other forms of alcoholic stimulus.

The plan of treatment sketched in the preceding pages is that which seems to me best adapted to ordinary cases of urethral gonorrhœa, and I have seldom found it necessary to resort to any other. Many surgeons place great reliance upon the internal administration of certain stimulating diuretics, especially copaiba and cubebs, which they employ to the partial or complete exclusion of the various injections which have been described. These remedies are, however, both inconvenient and disagreeable, and I believe in the large majority of cases quite unnecessary, though they may occasionally prove useful in the chronic stage of the affection. They may be administered separately or together, and may be combined with alkalies, and given either in pill or as an emulsion. When copaiba alone is to be prescribed, a convenient form is the gelatine capsule, containing twenty drops. On account of the disagreeable taste and nauseating quality of copaiba, when swallowed, it has been proposed to use it by enema, or as an injection for the urethra. I have employed the latter plan, but without benefit, and indeed it appears that the effect of the drug can only be obtained by allowing it to pass through the kidney, and thus medicate the urine.

Other modes of treatment have been used, and may occasionally be tried with advantage: such are the application of blisters to the thigh, or even to the penis itself, painting the latter with tincture of iodine, the use of medicated bougies,[1] etc.

Complications of Gonorrhœa.—The complications of gonorrhœa which require special notice, are chordee, inflammatory bubo, strangury, retention of urine, hemorrhage from the urethra, perineal abscess, and epididymitis.

1. *Chordee* consists of a painful erection, in which the inflamed state of the urethra prevents the spongy portion from becoming elongated to the same extent as the cavernous portions of the penis. Hence the organ often presents a twisted appearance, and laceration of the lining membrane of the urethra, or of its submucous tissue, may take place, giving rise to hemorrhage, or laying the foundation for the development of stricture. The *treatment* consists in the use of camphor and opium by the mouth, or as a suppository, in the application of an ice-bag to the perineum, in inunction of that part with belladonna ointment, or, as suggested by Otis, of New York, in the application of dry cold to the penis by Petitgand's method of "mediate irrigation" (p. 55). Inhalations of amyl nitrite have afforded relief in some cases.

2. *Bubo.*—The inguinal lymphatic glands occasionally become inflamed in cases of gonorrhœa, constituting the *sympathetic* or *inflammatory bubo.* The *treatment* consists in endeavoring to promote resolution by the application of blisters or the tincture of iodine; if suppuration occur, the pus should be evacuated through a small incision made in the direction of the long axis of the body, and the after-treatment conducted as in a case of ordinary abscess.

3. *Strangury and Vesical Irritation* may arise from inflammation of the prostate, or of the neck of the bladder; or, at a late stage, apparently from an atonic state of the part; the *treatment* consists in the use of warm fomentations and hip-baths, with anodynes, such as Dover's powder, or the tincture of hyoscyamus. The introduction of lumps of ice into the rectum is highly commended by Horand. When of the atonic form, advantage may be derived from the use of the mineral tonics.

4. *Retention of Urine,* if dependent upon spasm or inflammatory swelling, should be treated by the use of the warm bath, with full doses of opium, and perhaps leeches to the perineum, catheterization being avoided if possible. If an instrument be required, a *large flexible catheter* should be used *without the stylet.* If the retention arise from prostatic or perineal abscess, or from stricture, other measures may be required, which will be described in the proper place.

5. *Urethral Hemorrhage* may occur in the form of capillary oozing, or may result from rupture or laceration of large vessels, as a consequence of chordee, or of attempts at catheterization. The *treatment* consists in the local use of cold, or in pressure, applied by introducing a full-sized catheter and strapping the penis to the instrument.

6. *Perineal Abscess* may occur as a complication of gonorrhœa, and, beside causing great suffering, may give rise to retention of urine; the *treatment* consists in the use of poultices or warm fomentations, with an early incision in the median line, so as to prevent, if possible, the abscess from opening into the urethra—an occurrence which would almost certainly be followed by the formation of a perineal fistula. An early incision is also required in the rare case of an *Urethral Abscess* appearing in front of the scrotum.

7. *Epididymitis, Hernia Humoralis, or Swelled Testicle,* is one of the most important complications of gonorrhœa, rarely occurring before the third,

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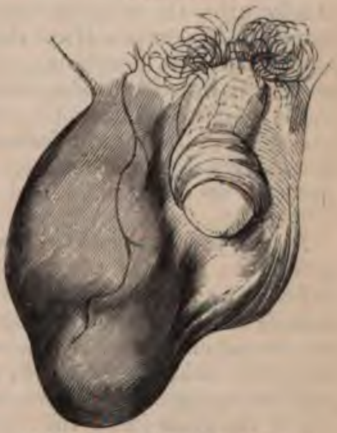
[1] Bougies, or urethral suppositories, containing iodoform and the oil of eucalyptus, are recommended by Cheyne, of King's College Hospital, London.

and usually as late as the sixth, week of the disease. From the fact that it commonly appears as the discharge from the urethra is diminishing, it was formerly considered a *sympathetic* or *metastatic* affection, but it is now pretty well established that it is merely the result of the extension of inflammation from the prostatic portion of the urethra, through the ejaculatory ducts and vas deferens, to the epididymis, and more rarely to the testis itself. The *left* side is more often affected than the *right*, probably because, as usually hanging lower in the scrotum, the left testicle is naturally less well supported by that structure; both testes are occasionally involved, rarely at the same time, but more often in succession or alternately. The *symptoms* are those of acute inflammation in any tense structure, great pain and tenderness, especially over the region of the globus minor, and marked swelling, which is, however, chiefly due to effusion into the tunica vaginalis (acute hydrocele). The *diagnosis* from *orchitis*, or inflammation of the testis proper, can only be made by noting the history of the case, and by observing the localization of the symptoms to the region of the epididymis. Epididymitis affecting an undescended testicle, or one retained in the inguinal canal, may be mistaken for inflammation of a lymphatic gland, or for strangulated hernia, but the true nature of the case, under such circumstances, will be at once suspected, if, on examining the scrotum, the testis be found absent from its place. The *prognosis* of swelled testicle is always favorable, but the globus minor may become permanently obliterated by the inflammation, and, if this should occur on both sides, the patient would, of course, be rendered impotent.

FIG. 194.



Gonorrhœal epididymitis. (LISTON.)

The *treatment* which I have for some years employed for this affection, when seen in the acute stage, is that which was suggested by Petit and recommended by Vidal (de Cassis), and which has been more recently revived by H. Smith, of London. It consists in making a puncture or limited incision into the inflamed organ at its most tender part, with a sharp and narrow straight bistoury; a few drops of blood follow the withdrawal of the knife, and the pain is almost instantaneously relieved, the tenderness quite or almost disappearing within twenty-four or forty-eight hours. The patient is confined to bed for a few days, with the scrotum supported on a pillow, and covered with a cloth dipped in cold water, or in lead-water and laudanum. The use of urethral injections should be temporarily discontinued, and may be resumed, if necessary, when the acute symptoms have subsided. Iodine ointment, or some similar sorbefacient, may be used to remove the induration of the globus minor, which often remains after all tenderness has disappeared. This mode of treatment has proved in my hands perfectly satisfactory, the pain being at once relieved, and resolution following without any unfavorable occurrence. Several cases have, however, been recorded by Demarquay and Salleron, in which hernia and complete extrusion of the seminiferous tubules followed the incision, the patient being thus effectually castrated on the affected side; the incision is said, in Salleron's case (*Arch. Gén. de Méd.*, Fév. 1870), not to have exceeded one centimetre in length—about four-tenths of an inch. On the other hand may be placed the remarkable success obtained by Vidal and Smith, the former surgeon having punctured 400 testes, without one bad result, while the latter declares that the method has served him well in 500 cases. To guard against the accident which occurred to Demarquay and Salleron, it would be prudent, however, to limit the incision to one not exceeding a quarter of an inch in length. This little operation appears to act by relieving the tension due to the want of expansibility of the tunica albuginea; it is therapeutically analogous to the incisions practised in cases of paronychia, and, in the words of Mr. Hutchinson, "appears to relieve pain much with the same certainty that iridectomy does in acute glaucoma."

Other modes of treatment have been recommended for epididymitis, among which may be mentioned Velpeau's plan of making numerous punctures of the tunica vaginalis with the point of a lancet, Fricke's method of strapping the testicle with adhesive plaster (very painful during the acute stage), the application of ice, as advised by Borgioni, or of iodoform ointment, as practised by Alvares, Langlebert's method of surrounding the scrotum with wadding and India-rubber cloth and applying a suspensory bandage, and the plan recommended by Mr. Rouse, of St. George's Hospital, who relies chiefly upon the administration of opium, in doses of a grain, night and morning (*St. George's Hosp. Rep.*, vol. iv. pp. 251–258). The plan formerly advised in most text-books, and still favored by many surgeons, consists essentially in local bleeding and the free use of tartar emetic and calomel—in the adoption, in fact, of a decidedly "antiphlogistic" course of treatment.

Among the rarer complications of gonorrhœa must be mentioned *peritonitis* and *subperitoneal abscess,* due, according to Faucon, to irritation transmitted from the vas deferens, seminal vesicles, prostate, bladder, ureters, or kidneys.

Balano-posthitis, or External Gonorrhœa, is the name given to inflammation of the prepuce and glans penis. When confined to the former, it is called *balanitis,* and when limited to the latter, *posthitis.* This affection is usually due to exposure in coitus, but may result from the irritation caused by the accumulation of smegma, in cases of phimosis, or in persons who neglect ablution. It is chiefly seen in those whose prepuce is elongated, and may be very generally prevented by the practice of circumcision, the covering of the glans losing the character of mucous membrane after this operation, and becoming assimilated to skin. The *symptoms* are those of ordinary muco-purulent inflammation, and the affection is often accompanied with a temporary phimosis. The *treatment* consists in the application to the inflamed surfaces of the solid stick of nitrate of silver, or in packing the preputial fold with lint dipped in a solution of the same salt (℈j–ı℥j), the whole penis being then surrounded with an evaporating lotion. If phimosis exist, it may be necessary to relieve this by an operation which will be described in another portion of the volume.

Gonorrhœa of the Female Generative Organs is usually limited to the *vulvo-vaginal canal,* though the *urethra* is occasionally affected, as are likewise the lining membranes of the *uterus* and *Fallopian tubes.* The *ovaries* may be secondarily inflamed (furnishing a pathological analogy to the swelled testicle of the male), or *peritonitis* may ensue from the escape of gonorrhœal matter into the cavity of the abdomen. The *symptoms* are those of acute inflammation, attended with profuse muco-purulent discharge. The *diagnosis* from leucorrhœa and from ordinary vulvo-vaginitis, is often difficult, and occasionally impossible. Leucorrhœa usually proceeds chiefly from the womb, while gonorrhœa affects principally the exterior parts, but these positions may be occasionally reversed. Muco-purulent vulvo-vaginitis may, as is well known, result from various causes independently of contagion, such as exposure to cold and moisture, the presence of ascarides, external violence, masturbation, or immoderate coitus. Hence, the surgeon should be very cautious in pronouncing an opinion as to the nature of a suspicious discharge in a woman, and particularly in a female child, as vaginal discharges in children are not unfrequently made the ground of criminal accusations against totally innocent persons. Even the implication of the urethra is not positive, though it is certainly *primâ facie* evidence of the inflammation being the result of impure contact.

The *treatment* of gonorrhœa, in the female, should, during the acute stage, be limited to the use of laxatives and diaphoretics, with warm hip-baths and emollient fomentations to the external parts. In the subacute stage, astringent injections (especially of alum or sulphate of zinc) may be used, the patient applying them herself by means of a self-injecting enema apparatus (in quantities of not less than a pint), or the surgeon making the application through a speculum. In either case the patient should be recumbent, with the hips somewhat elevated. After the use of an injection, it is well to keep the inflamed surfaces apart by introducing a strip of lint, or a small tampon, dipped in the astringent solution. Another plan, proposed by the late Sir J. Y. Simpson, is to introduce medicated pessaries, or vaginal suppositories. This method has, according to Dr. Black, been successfully employed in the women's venereal wards of the Philadelphia Hospital. Vaginal poultices are employed by Fournier. When the urethra is affected, injections may, if thought proper, be employed as in the male, or copaiba and cubebs may be administered internally. The inflammation may persist in the vulvo-vaginal ducts and Cowper's glands long after apparent recovery. *Bubo* rarely follows gonorrhœa in the female, but, when met with, should be treated as in the male.

Ophthalmic Gonorrhœa, or, as it is usually called, *Gonorrhœal Ophthalmia* or *Conjunctivitis*, is produced by direct inoculation of the palpebral or conjunctival mucous membrane with gonorrhœal matter, and must not be confounded with a form of ophthalmia principally affecting the sclerotic, which is dependent upon what will be presently described as gonorrhœal rheumatism.

Ophthalmic gonorrhœa usually affects but one eye, and runs a very rapid course, ending, if not checked, in destruction of the organ. It is more frequent in men than in women, and is believed by some writers only to accompany cases of urethral gonorrhœa. The *symptoms* are first manifested in from six to eighteen hours after inoculation. The discharge, at first thin, soon becomes thick, purulent, and profuse. The conjunctiva is the seat of great chemosis, rising above and partially overlapping the cornea, while the eyelids swell and often completely close the eye. The cornea soon becomes hazy, ulceration occurs (usually near the margin), perforation follows, with perhaps prolapse of the iris and consequent staphyloma, or the whole cornea may slough, in which case the eye is of course irretrievably lost.

The *treatment* must be both constitutional and local: the practice of depletion, which was formerly common in these cases, is now generally abandoned, it being recognized that the disease is invariably one of depression. The bowels having been relieved by a laxative, the patient should be at once put upon the use of quinia, with or without the mineral acids, and should take concentrated food in the form of beef-essence, with alcoholic stimulus if required. The *local treatment* is of the highest importance. The *sound* eye should be protected by the application of a compress of charpie, held in place by a disk of adhesive plaster covered with collodion, or by the use of an ingenious bandange devised by Mr. Buller, of London, which consists of a square piece of Mackintosh fitted with a watch-glass, and fastened by adhesive plaster. If there be much chemosis, radiating incisions through the swollen conjunctiva should be practised, as recommended by Tyrrell, and, in any case, a strong solution of nitrate of silver (℈j or ij–f℥j) should be freely painted with a camel's-hair brush over the inflamed surfaces, and allowed to remain a few seconds until the part is whitened, when the surplus should be washed off with a gentle stream of tepid or cool water. This application may be repeated once or twice a day, according to the severity of the case, while a weaker solution (gr. v or x–f℥j) should be instilled every three or four hours, and the accumulating discharge very frequently washed away with a weak solution of alum, applied with a syringe, or squeezed from a piece of lint. Bader employs an ointment of the red oxide of mercury, gr. j to ℥j, with $\frac{1}{5}$ gr. of daturia. Free and, if necessary, repeated division of the external canthus, so as to relieve the eye from pressure, is recommended by Van Buren and Keyes, while Critchett goes further, dividing the upper lid as far as the margin of the eyebrow, and separating the flaps thus made, and keeping them apart with sutures attached to the brow during the whole course of treatment, the lid being subsequently restored by a plastic operation. If perforation of the cornea be threatened, instillations of atropia should be resorted to, so as to prevent, if possible, prolapse of the iris. Cold applications may be employed throughout the duration of the disease, if agreeable to the patient, while opium may be given in full doses to relieve pain. As the severity of the inflammation subsides, the application of the strong solution of nitrate of silver may be stopped, the use of the weaker solution being continued until convalescence is established. A granular condition of the lids is sometimes left, requiring the occasional application of the sulphate of copper in substance.

FIG. 195.

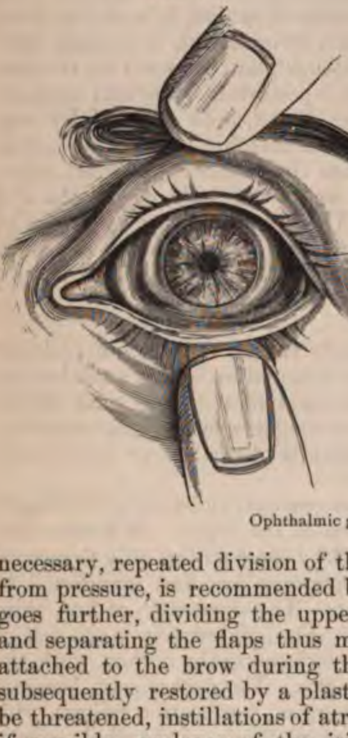
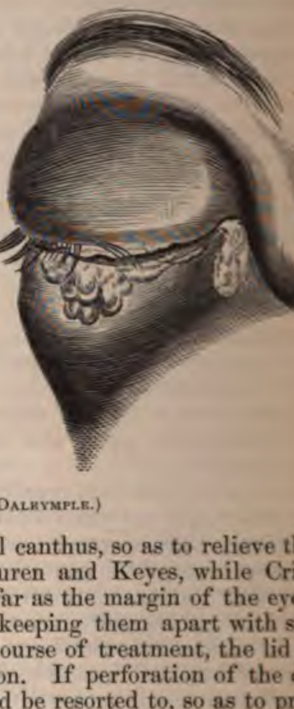


FIG. 196.



Ophthalmic gonorrhœa. (DALRYMPLE.)

Counter-irritation, by blisters or tincture of iodine, applied in the form of a horseshoe to the brow and temple, has recently been highly recommended in cases of ophthalmic gonorrhœa by Furneaux Jordan.

Gonorrhœa affecting the Nose, Mouth, Rectum, or Umbilicus, presents no features of special interest; in each locality it requires the use of emollient applications during the acute stage, and of stimulating astringents at a later period. *Rectal gonorrhœa* may prove an occasional cause of organic stricture of that portion of the alimentary canal.

Gonorrhœal Rheumatism is a sequence of gonorrhœa which is almost exclusively confined to the male sex, and which, in the rare instances in which it is seen in women, seems to be dependent upon implication of the urethra in the gonorrhœal affection, never occurring, according to Cullerier, in cases of simple vaginal gonorrhœa. It is, in fact, a variety ot *urethral fever*, and is probably due to the absorption of septic material generated in the muco-purulent secretion of urethritis, being thus (as has already been remarked) a mild form of pyæmia. It has been objected, by some, to this explanation, that, if pyæmic, the disease should arise equally from vaginal as from urethral gonorrhœa, and it has been maintained that its invariable urethral origin indicates a peculiar sympathetic connection between the urinary canal and the articulations, and that the affection must therefore be considered *metastatic*. Other writers have regarded the connection as accidental, and taught that a rheumatic diathesis was a necessary antecedent; while others, again, have looked upon the rheumatic manifestations as indicating the essential identity of gonorrhœa and syphilis. It is well established, however, that, in very many cases, no antecedent rheumatic diathesis can be traced; while, apart from the total want of resemblance between this affection and constitutional syphilis, and the fact that the latter does, and that this does not, arise from vaginal infection, the absolute diversity of the diseases has been so clearly established by the unerring test of inoculation, as to render the suggestion of their identity scarcely worthy of consideration. The notion of metastasis is disproved by the fact that the urethral discharge does not usually disappear, but is rather increased, upon the development of the rheumatic symptoms, while the anatomical differences in the structure of the urethral and vaginal mucous and submucous tissues, are quite sufficient to account for the occurrence of septic absorption from one and not from the other.

Gonorrhœal rheumatism affects principally the joints (particularly the knee and ankle), the synovial bursæ, the muscles and tendons, and the sclerotic coat of the eye, from which, however, it may extend to the conjunctiva, or to the iris and cornea. The *articular* symptoms resemble those of rheumatoid arthritis, rather than those of acute rheumatism, the disease not tending to attack many joints in succession, and being very rarely accompanied with cardiac complications, though blenorrhagic endocarditis is described by Lacassagne, Désnos, Marty, Baudin, and Cianciosi. The joints are painful and swollen, and occasionally reddened; the inflammation rarely ends in suppuration, but not unfrequently in false anchylosis. The *muscular* affection is principally manifested in the fleshy parts of the thigh and arm, and in the soles of the feet. *Gonorrhœal Rheumatic Ophthalmia* is attended with pain, dimness of vision, photophobia, and lachrymation; if the conjunctiva be much involved, there may be a muco-purulent discharge, but there is not much chemosis, and the cornea very rarely ulcerates. Iritis may result in adhesion to the capsule of the lens, and permanent impairment of vision. *Pericarditis* and *Endocarditis* are occasional complications of gonorrhœal rheumatism, and sometimes follow gonorrhœa without the occurrence of other rheumatic symptoms. According to Marty, the aortic are more often affected than the mitral valves.

The *treatment* of the articular affection is best conducted by the use of repeated blisters, and by the internal administration of anodynes, with or without quinia, according to the constitutional condition of the patient; in the later stages, compression by means of adhesive strips may be employed with advantage. If suppuration be imminent, the intra-articular fluid may be withdrawn by means of a capillary trocar and aspirator, as advised by Laboulbène. The iodide of potassium is particularly adapted to those cases in which the muscular and fibrous structures are affected, and may be given in large doses. The same remedy may be employed in the ophthalmic variety of the disease, and may be supplemented by the oil of turpentine, in drachm doses, if the iris be involved; in the latter case instillations of atropia should also be practised, while astringent collyria may be required if there be much conjunctivitis. Counter-irritation, by blisters or iodine, may be applied to the temples, if thought necessary, or a more permanent effect may be produced, as suggested by Dr. W. Thomson, of this city, by applying the mouth of a bottle containing a small quantity of *bromine*—a brief contact with the vapor of this powerful agent sufficing to produce an eschar which will continue for several weeks.

CHANCROID.

The Chancroid, or Simple Venereal Ulcer (often called *Soft*, or *Non-infecting Chancre*), is a strictly local affection, resulting from contact with the secretion from a similar sore in the same or another person.[1] It is usually acquired in impure coitus, but may be mediately transmitted by means of towels, etc. Surgeons, or accoucheurs, are occasionally infected in the discharge of their professional duties, particularly if they happen to have abrasions on the fingers at the moment of exposure.

Locality.—Any part of the body may be the seat of chancroid, though the most usual position is, of course, the generative organs—in the male about the preputial fold, corona glandis, frænum, and urinary meatus, and, in the female, about the nymphæ, or os uteri. It was formerly supposed that the cephalic region was insusceptible to this affection, but it is now known that the chancroid can be readily artificially inoculated upon the face, and at least seven cases (Puche, Rofeta, Diday, Labarthe, R. W. Taylor, Venot—two cases), are on record, in which a cephalic chancroid resulted from the ordinary mode of contagion.

Course.—The chancroid has no period of incubation, the varying intervals between exposure and the appearance of the sore, depending upon whether the contagious matter is deposited upon an abraded, a delicate and soft, or a thick and callous surface. When artificially inoculated, the first symptoms appear within a few hours, the inoculated point becoming elevated and surrounded with a red areola, in the course of the second or third day. The papule thus formed, in another day becomes a vesicle, and subsequently a pustule, which either bursts, exposing the chancroidal ulcer, or dries into a scab beneath which the ulceration progresses. If the chancroidal matter be deposited in an abrasion, the ulcerative stage may begin at once. The fully-formed chancroid is thus usually developed from four to six days after exposure,[2] and appears as a round ulcer, from a line to half an inch in diameter, unadherent to the subjacent tissues, with sharp-cut edges, as if punched out of the skin, covered with an adherent gray slough, furnishing pus which is *auto-inoculable*,[1] and at first surrounded with a reddish areola. It is commonly multiple, eighty per cent. of affected persons having, according to Fournier's observations, from two to six sores each. The chancroid may present, at its base, a slight degree of hardness, which is the result of inflammatory action, but which must not be mistaken for the induration commonly observed in the true *chancre*, or initial lesion of syphilis.

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[1] Kaposi, Bumstead, and some other writers, believe that chancroid results from the inoculation of pus from any source, as from acne, the pustules of scabies, etc. This view seems to me to lack confirmation, and is certainly contrary to anything that I have observed in my own practice.

[2] F. N. Otis, however, records a case in which the chancroid did not appear until the *tenth*, and was not fully formed until the *thirteenth*, day.

Bubo.—The chancroid is not unfrequently followed by swelling of the inguinal glands, or bubo, which may come on at an early period, but from the risk of which the patient is never free as long as the chancroidal ulceration continues: Puche met with it three years after infection.[2] The bubo which follows chancroid may be of the simple inflammatory variety, such as is seen in cases of gonorrhœa, or after injury—or may be the result of direct absorption of chancroidal pus, in which case it receives the name of *virulent* or *chancroidal bubo.* The chancroidal bubo is usually *monolateral*, and commonly on the same side as the sore from which it originates, though it is occasionally seen on the opposite side, as the result of the interlacement of the lymphatics on the dorsum of the penis. It affects only the superficial glands, and only one at a time; hence, it is said to be *monoganglionic.* The chancroidal bubo invariably tends to suppuration, the resulting ulcer being precisely analogous to the original chancroid, and furnishing a contagious and auto-inoculable pus. Sometimes suppuration occurs first in the areolar tissue around the affected lymphatic gland, when the abscess will not assume the chancroidal character until disintegration of the gland itself has begun. The chancroid and chancroidal bubo have little or no tendency to a spontaneous cure. While one ulcer is healing, others may be produced by auto-inoculation and fresh glands involved by absorption, the disease, perhaps, being thus prolonged until the patient is carried off by some intercurrent affection, or dies utterly worn out by suppuration and long-continued suffering.

Complications.—A chancroid may be complicated by the existence of warts or vegetations (which are by no means necessarily of a venereal origin); by inflammation of the penis and prepuce, which may lead to phimosis or paraphimosis, or to gangrene of the prepuce; by the coexistence of gonorrhœa or of syphilis; and by *phagedænic* or *serpiginous ulceration.*

Phagedænic Ulceration is a very serious complication, and is apparently due more to the constitutional condition of the patient than to any peculiar virulence of the source of contagion; it is, in other words, not a distinct variety of chancroid, but a complication which may affect any simple venereal sore. Its occurrence is sometimes traceable to distinct sources of depression, such as intemperate habits, the previous existence of syphilis, or the abuse of mercury. The phagedænic chancroid is attended with wide and deep erosion of tissue, a considerable portion of the head of the penis being occasionally eaten away in the course of a few hours, and the disease sometimes not being arrested until almost the whole organ has perished. The ulcer is usually covered with a yellowish-gray, pultaceous slough, the appearance of which is compared by Barton to that of melted tallow, though the slough may in other cases be blackened by exposure. Phagedænic ulceration may attack a chancroidal bubo, and death may result under such circumstances either from exhaustion or from hemorrhage—by the giving way of the femoral artery—as happened in a case recorded by Sir A. Cooper.

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[1] That is, which can, by inoculation, produce in the *same person* a sore of the *same nature* as that from which it was derived.

[2] According to Horteloup, chancroidal pus may be absorbed and remain latent in a lymphatic gland for many months, finally causing a true chancroidal bubo long after the original chancroid has been completely healed.

Serpiginous Chancroid.—The *serpiginous* or *creeping chancroid* differs from the preceding, chiefly in pursuing an extremely chronic course. This complication, which is fortunately rare, is exceedingly intractable, occasionally persisting for many years. It usually occurs in the groin, attacking perhaps an open chancroidal bubo, and slowly creeps onwards, eroding the adjoining skin at one part, while a thin blue or violet cicatrix forms at the opposite side of the ulcer. It is chiefly seen in persons whose constitutions have been undermined by long-continued want and neglect.

Diagnosis.—From herpetic or aphthous eruptions on the prepuce or glans penis, and from excoriations from mechanical causes, the chancroid may be ordinarily distinguished by the fact that the former make their appearance almost immediately after the suspicious connection, while the latter is not usually fully developed before the fourth day. In some instances, however, the diagnosis is extremely difficult, though it may be determined by observing the further progress of the affection, or by inoculation, which, in the case of herpes, etc., will give a purely negative result. If the chancroid be situated within the urethra, it may simulate *gonorrhœa;* if within the cervix uteri, *leucorrhœa;* and if on the glans, and complicated with phimosis, *balanitis.* Here, again, to ascertain the nature of the affection, it may sometimes be necessary to resort to inoculation, which proceeding, if the affection be chancroidal, will result in the formation of a chancroid, but in the case of gonorrhœa, etc., will result merely negatively. The diagnosis from *chancre*, or the initial lesion of syphilis, will be considered when we come to speak of that affection. All of these diseases may exist together, and it thus sometimes happens that the same woman may infect three persons differently, according to their several susceptibilities, giving to one gonorrhœa, to another chancroid, and to a third syphilis.

Prognosis.—The prognosis of a case of uncomplicated chancroid, if this be properly treated, is always favorable; the phagedænic chancroid is a more serious affection, frequently entailing considerable loss of substance, though rarely endangering life, unless neglected; the serpiginous chancroid is the most intractable form of the affection, and the surgeon should be very guarded in his prognosis of a case of this kind, as, though not in itself attended by any particular risk to life, it often persists for years, in spite of the most judicious treatment.

Treatment.—I shall first describe the treatment of the ordinary chancroid, or simple venereal ulcer, indicating subsequently the modifications required by the various complications of the disease. In the first place, it is to be observed that, as the chancroid is a strictly local affection, it requires, in itself, merely topical treatment. If any constitutional remedies are to be employed in a case of chancroid, they are only such as are indicated by the patient's general condition, without regard to the particular disease with which he is affected. The first object to be accomplished, as soon as the surgeon has made up his mind that he has to deal with a chancroid, is to apply some agent which will entirely destroy the whole surface of the ulcer, thus removing at once the tendency of the disease to spread, and converting the sore into a healthy granulating surface. To do this, various forms of caustic may be employed, the best, in my judgment, being the strong nitric acid. The surface of the sore having been carefully dried with lint, the acid is applied on the end of a piece of soft wood, well rounded and smoothed (this is better than a camel's-hair brush), in such a way as to reach every portion of the ulcer. Every cranny and crack should be permeated, as any portion of the chancroidal surface which escapes will reinoculate the whole ulcer. After the acid has remained a few moments, it may be washed off with a stream of cool water. The effect of the application is to convert the whole surface into a slough, upon the detachment of which a healthy ulcer is left, which rapidly fills up and becomes cicatrized, the pus, however, retaining its contagious character until the ulcer is almost, if not until it is quite, healed. If there be a number of chancroids, or if the surface to be cauterized be very extensive, it may be necessary to resort to anæsthesia before applying the acid, or, as has been recently suggested, a preliminary application of carbolic acid may be made, so as to utilize the local anæsthetic power of this agent. One application of nitric acid, if thorough, is sufficient, but it occasionally happens that, in spite of the surgeon's care, some portion of the ulcer escapes, when the cauterization must be subsequently repeated once or oftener. After the cauterization, water-dressing or lime-water may be applied until after the separation of the sloughs, when the remaining ulcer should be treated upon general principles. Black-wash (calomel ʒj, lime-water Oj) answers a very good purpose as a stimulating astringent, but has no specific virtue. A solution of salicylic acid is recommended by Boyland, of Baltimore. Iodoform, in powder, in the form of ointment (gr. xv to xxx–℥j), or in solution with glycerin and alcohol (iodoform ℈iss, glycerin fʒvj, alcohol fʒij), is an excellent application which has been particularly recommended by Izard, and by Damon, of Boston. The solution may be employed as long as there is profuse suppuration, while the powder and ointment are particularly useful in a later stage of the affection. Autier recommends a two-per-cent. solution of salicylic acid in glycerin.

Chancroid in the Female should be treated in the same way, the acid being carefully applied in these cases through a suitable speculum; black-wash may be used as an after-dressing, or the *aromatic wine*,[1] which is a more elegant though somewhat expensive preparation. If the chancroid be seated in the *male urethra*, at such a point that it cannot be seen by separating the lips of the meatus, it may be touched through the tube of an endoscope with a strong solution of nitrate of silver (ʒss–f℥j); the use of nitric acid in this situation is undesirable, on account of the risk of a stricture following its caustic action. Chancroids on surfaces which are ordinarily in contact, as the glans and lining membrane of the prepuce, or the inner surfaces of the nymphæ, should after cauterization be kept apart by the interposition of a fold of lint, dipped in black-wash or other astringent lotion.

Treatment of Bubo.—In the treatment of a bubo occurring after a chancroid, as it is impossible in the first instance to determine whether it be really a chancroidal, or merely an inflammatory, bubo, an effort should be made to promote resolution by the use of blisters, iodine, or iodoform, which may be conveniently applied in the form of an ointment (gr. xxx–℥j). If, however, suppuration have evidently occurred, and particularly if the integument be thin and discolored, it is better to make a free opening (by an incision in the direction of the long axis of the patient's body), so as to evactuate the contents of the abscess, and the ulcer which remains, if it assume the chancroidal character, must then be treated as the original sore. Some surgeons prefer to open a chancroidal bubo with caustic potassa, but I do not see that this agent is in any way preferable to the knife, while it is certainly more painful. It sometimes happens that, when the pus is evacuated from a chancroidal bubo, an enlarged lymphatic gland is found, more or less dissected from the surrounding tissue, and projecting through the lips of the incision: this gland is filled with chancroidal matter, and as long as it remains will keep up the specific nature of the sore; and though it will in time undergo spontaneous disintegration, other glands will by that time have been infected, and the disease will thus be perpetuated. Such a chancroidal lymphatic gland should be therefore removed; this may be accomplished by repeated applications of caustic, but is much more conveniently effected by *enucleation*, which consists simply in seizing the gland with forceps, and dissecting it from its attachments.

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[1] The following formula is taken from Bumstead: Claret wine, Compound spirit of lavender, of each f℥v; Tincture of opium f℥ss; Water f℥iijss; Tannin ʒj–℥j. Mix. To be diluted if necessary.

Before proceeding to cauterize an opened chancroidal bubo, the patient should be thoroughly anæsthetized, as the operation is usually both tedious and painful. The first step consists in tracing out and slitting up every sinus that can be detected, with a grooved director and probe-pointed bistoury; the flaps of undermined and unhealthy-looking integument are next to be clipped away with scissors; enlarged glands to be carefully enucleated; and finally the strong nitric acid to be thoroughly applied to every portion of the surface, and even a short distance beyond the incisions, with the same precautions as in the cauterization of the original chancroid. A large slough is thus formed, the detachment of which is the work of some time; water-dressing may be applied after the cauterization, the subsequent treatment being conducted on general principles. The management of a chancroidal bubo is thus seen to be a much more serious affair than that of the chancroid itself; hence the importance of prompt and effectual treatment of the original sore, that absorption may, if possible, be prevented.

Warts.—The treatment of venereal warts does not differ from that of vegetations on the generative organs arising from other causes, and will be described in a subsequent chapter.

Phimosis.—A troublesome complication of chancroid on the prepuce or glans penis, is phimosis, which may be congenital, or the result of inflammatory action. A great objection to any cutting operation, in these cases, is that the cut edges themselves will almost certainly be inoculated with the chancroidal virus; hence, if the phimosis be the result of inflammation, it is better to attempt to subdue this by the use of cold washes, and by the injection of detergent lotions beneath the prepuce, when it will often be possible to draw back the latter and make the necessary applications to the glans. Another plan, which may be occasionally useful, is to pack the preputial fold with lint saturated with a solution of nitrate of silver, as recommended in cases of balanitis. If the phimosis do not yield, or if it be congenital, it will probably be necessary to slit up the prepuce, or, if the chancroid be seated near the orifice of the latter, to perform circumcision; if the cut edges in either case become inoculated, they must be freely cauterized with nitric acid.

Paraphimosis occurs as the consequence of the patient drawing back the prepuce and then being unable to return it; the necessary applications having been made to the chancroid, the prepuce may be restored to its place by the manipulation which will be described in the chapter on Diseases of the Generative Organs: the after-treatment consists in the use of cooling applications to relieve inflammation of the part.

Gangrene of the Prepuce is an occasional result of inflammatory phimosis, and is a very serious complication of chancroid. If, in any case of phimosis, the foreskin become much swollen, and of a dark red or purple hue, the surgeon may fear the occurrence of gangrene, and should lose no time in relieving the tension of the part by freely slitting up the constricting prepuce. If gangrene, however, have actually occurred, the surgeon's efforts must be chiefly directed to limiting its extension by the use of fermenting poultices and detergent injections, and by the internal administration of opium. Hemorrhage, occurring during the separation of the slough, may be checked by the use of the actual cautery. The patient may escape with the loss of a small portion of the prepuce, but occasionally the whole extent of this structure will perish, when it may be detached *en masse*, and leave the patient as effectually circumcised as by an operation. After the separation of the mortified part, the chancroids, which will now be fairly exposed, must be treated in the manner already described.

Phagedænic Chancroid.—In this serious affection, no time should be lost in detaching the slough, and in applying the strong nitric acid to the whole ulcerated surface in the manner already directed, the patient having been previously etherized if necessary. The subsequent dressings may be made with a solution of the potassio-tartrate of iron (a favorite remedy with Ricord), with one of chlorinated lime, with iodoform, or with an opium wash, if the part be inflamed and very painful. The application of a constant current of electricity is recommended by Schwanda, of Vienna, and the use of the continuous warm bath by Simmons, of Yokohama. Opium should be administered internally in such doses as to relieve pain without disordering the digestion, and alcoholic stimulus may be given in quantities proportioned to the age and strength of the patient. Tonics are usually required, the best being, probably, the potassio-tartrate or muriated tincture of iron, either of which may be given pretty freely. The diet should be nutritious but unirritating. The nitric acid should be reapplied as often as any tendency to a recurrence of phagedæna is manifested.

Serpiginous Chancroid.—In the treatment of this most intractable affection, free and repeated cauterization of the whole ulcerated surface and surrounding integument is the only remedy worthy of much confidence. The actual cautery is probably the best application in these cases, the subsequent dressings being made with chlorinated washes. The strength of the patient must be maintained by the use of tonics and the administration of suitable nutriment: opium may be given as often as required to relieve pain. Cases have been reported in which both phagedænic and serpiginous chancroids have been cured by the use of mercury or iodide of potassium, but there is every reason to believe that in these instances the affection was really syphilitic, phagedænic and serpiginous ulceration being occasionally, though rarely, met with as complications of both primary and tertiary syphilitic sores.

Primary Bubo or Bubon d'Emblee.—Under this name has been described an acute or subacute inflammation of an inguinal lymphatic gland, occasionally met with after coitus, and not connected with either gonorrhœa, chancroid, or syphilis. It is, in fact, a simple adenitis, resulting from mechanical irritation, usually in a patient of strumous constitution; and its symptoms and treatment differ in no respect from those of ordinary adenitis, an affection which will be considered in its proper place.

CHAPTER XXV.

VENEREAL DISEASES.—CONTINUED.

SYPHILIS.

SYPHILIS[1] is a constitutional disease, resembling in many respects the specific fevers, such as variola, etc., but differing from them in its much slower course, in its communicability only by direct or indirect inoculation, and in the possibility of its being inherited as well as acquired.

HISTORY.

The origin of syphilis has not been positively determined. The limits of this volume will not permit any discussion of the evidence which has been adduced by various authors as bearing upon the history of this disease (although the subject is one of very great interest), and I will therefore invite the reader to refer, for information upon this matter, to the various excellent monographs upon Venereal Diseases which have been published from the days of Astruc down to our own time. It may, however, be stated that (1) the disease does not appear to have been known to the ancients, though both the simple venereal ulcer (or chancroid) and gonorrhœa were unquestionably familiar to them; (2) there is no sufficient proof that syphilis originated in this country and was hence imported to Europe; and (3) although the disease certainly first attracted public attention in the latter part of the fifteenth century, during the campaigns of Charles VIII. of France, it is impossible, in view of existing evidence, to fix any particular date as the precise period at which syphilis originated.

CAUSES.

Syphilis may be *inherited* or *acquired*. *Hereditary syphilis*, in the great majority of cases, depends upon previous infection of the *mother*, though it is believed by Diday and others that the disease may be transmitted from a father to his offspring, the mother being only secondarily affected. Examples of hereditary syphilis are unfortunately not rare, and it is even believed, by Hutchinson, that the disease may be transmitted to the third generation. *Acquired syphilis* can only arise from *contagion*, which may be either *immediate* or *mediate*.

Immediate or Direct Contagion results from contact with a *chancre* (the primary lesion of syphilis), or with certain *secondary lesions*—particularly that which is known as the mucous patch—or from inoculation with the *blood* of a syphilitic person. It was formerly believed that syphilis was transmissible through the various secretions, especially the saliva, milk, and

[1] I have described in this chapter the pathology and treatment of syphilis, according to my own views (which are essentially those of the so-called "dualistic" school of syphilographers), believing that I should thus better subserve the purposes of the student than by entering, in the brief space at my command, upon a discussion of controverted points which are, after all, chiefly of theoretical interest.

seminal fluid; through contact with cutaneous surfaces of which the skin happened to be thin, as the lips; or even through the medium of the atmosphere. It soon became evident, however, that the assertions of patients upon these points were, for obvious reasons, not trustworthy, and a natural reaction ensued in medical opinion, which finally culminated in the axiom of Hunter, which, until lately, was generally received as correct, that the primary sore alone was contagious, and that hence syphilis could only be acquired by contact with a chancre. It has now been repeatedly established, by both clinical observation and direct experiment, that certain secondary manifestations of syphilis are contagious, while it has, on the other hand, been rendered almost equally clear, that the supposed instances of contagion through secretions are really examples of contagion from secondary lesions; thus where the *saliva* has been supposed to convey the disease, there have been mucous patches in the mouth of the infecting person, and Cullerier has shown, at the Lourcine Hospital, that it is not the *milk* of a syphilitic woman that infects her nursling, but the secondary lesions which are found upon her breast. The only possible exception is in the case of the *semen*, and even here there is no positive evidence that a woman can receive syphilis from the seminal fluid, unmixed with the product of urethral sores or with blood, while negative evidence has been furnished by experimental inoculations practised by Mireur, of Marseilles. That the *blood* of a syphilitic person may prove the source of contagion, has been demonstrated by both experiment and clinical experience, as well as by observation of the fact that syphilis may be transmitted by *vaccination*, when blood is mixed with the lymph obtained from a syphilitic child, while vaccine matter does not appear to be capable of conveying syphilitic infection, if care be taken to exclude the admixture of blood.[1] The *menstrual discharges* of syphilitic women are, as pointed out by Hyde, of Chicago, probably not unfrequently a source of contagion.

Mediate or Indirect Contagion.—The contagious matter from a syphilitic sore may be transmitted to a previously healthy person by means of spoons, drinking-cups, sponges, catheters, etc. Rollet has recorded a number of cases of this nature, and similar cases have since been published by Cullerier, Barton, and others. Hence, though surgeons may justly look with suspicion upon the statements often made by syphilitic patients, that their disease has been acquired in water-closets, etc., it should always be remembered that such an occurrence is at least possible, and care should be taken not to wound the feelings of others, and perhaps cause domestic unhappiness, by expressing an unguarded opinion, which, after all, may be erroneous. Tardieu, Hutin, Simonet, Maury, and Robert have observed cases in which syphilis had been transmitted by *tattooing*, the coloring matter having been mixed with saliva from the mouth of a person affected with mucous patches.

Course or Natural History of Syphilis.

(*Including its Morbid Anatomy.*)

The course of syphilis varies according as the disease is hereditary or acquired. The latter form of the affection will be first considered. The natural history of a typical case of acquired syphilis is usually described as going through three stages, known respectively as primary, secondary, and tertiary syphilis; and this convenient and time-honored division is that which I shall adopt. Ricord's classification subdivides the second period, by making a late-secondary stage, while Lancereaux adds a preliminary stage, or that of incubation. A recent writer, Dr. Barton, of Dublin, modifies Ricord's division by omitting the late-secondary stage, and subdividing the tertiary into the period of sthenic or lymphy deposits, and that of asthenic or gummy deposits — a subdivision which seems unnecessary, as both these forms of deposit frequently coexist in the same case. The classification of Virchow and other German writers, based strictly upon the pathological changes produced by syphilis, though scientifically correct, is less convenient than that which is founded on its clinical characters. Syphilis is then to be studied in its *first* stage, or that of *primary symptoms*—chancre and syphilitic bubo; *second* stage, or that of *secondary symptoms*—early eruptions and sore throat, the period of general superficial lesions; and *third* stage, or that of *tertiary symptoms*—the period of late eruption, ulceration, and deposit.

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[1] Vaccination with pure vaccine matter may, however, hasten the development of latent syphilis. It has been recently suggested that syphilis may be conveyed in vaccination by the admixture with the vaccine lymph of epidermic scales, or of pus, as well as of blood.

PRIMARY SYPHILIS.

Incubation.—A variable period of *incubation* intervenes between exposure to contagion and the appearance of a *chancre*. This period has been estimated by different observers at from one to seven weeks, and it is probably safe to say that the average is from two to three weeks. Cases have been recorded by Hammond, R. W. Taylor, and others, in which the period of incubation has been but one or two days, while in other instances a much longer period than the average—as much as ten or eleven weeks—has intervened between exposure and the development of the chancre. The period of incubation is, according to F. N. Otis, directly proportional to the distance between the point of inoculation and the proximal lymphatic vessels. Whatever be the source of acquired syphilis, whether from a primary or secondary lesion, the first symptom is invariably a chancre.[1] This fact is of great importance, and may be considered as an axiomatic truth.

Varieties of Chancre.—The chancre assumes various forms, and there appears to be some relation between these and the severity of the subsequent symptoms; thus what is known as the "Hunterian" or "deep chancre" is commonly the precursor of a severer case of syphilis than a "superficial erosion." We may recognize two principal forms of chancre, the *superficial* and the *deep*, and either of these may assume a phagedænic form, constituting a third variety, the *phagedænic* chancre.

1. *The Superficial Chancre, Chancrous Erosion, or Superficial Erosion*, is by far the most common form of chancre, and is that which usually results from contact with secondary lesions. Of 170 cases tabulated by Bassereau, no less than 146 were of this variety. It has a long period of incubation—from three to five weeks—and appears as a reddish-brown papule (rarely, if ever, as a pustule), usually with an ulcerated spot in the centre, but sometimes (particularly if seated on an exposed surface) covered with a dry, brownish scab. The ulcer is commonly circular or irregularly elliptical in shape, slightly if at all excavated, red in color, and furnishes a thin serous

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[1] This remark, of course, applies to syphilis acquired in the ordinary way; it is possible that were the syphilitic poison carefully introduced directly into a lymphatic vessel, or into a vein, a chancre might not result, but that in the former case a syphilitic bubo, and in the latter constitutional syphilis, might occur as the primary lesion, as it does in the case of the hereditary form of the disease.

exudation, without pus, unless as the result of extraneous irritation. When taken between the thumb and finger, the margin and base of the ulcer present a cartilaginous or membranous hardness, known as *parchment-like induration.* This induration is of variable persistence, and sometimes disappears before the ulcer has healed. It is much less evident when the chancre is situated in mucous, than when in cutaneous, tissue, and hence in certain situations, as in the male urethra or upper part of the vagina, this form of chancre may readily escape detection.

2. *The Deep Chancre* (commonly known as the *Hunterian Chancre*) has a comparatively short period of incubation—from a week to ten days—and is apparently of rarer occurrence at the present day than formerly. It presents a deep excavated ulcer, with elevated, sloping margins and a foul surface, furnishing a serous exudation often tinged with blood. The base of this chancre is deeply indurated, the sensation communicated to the fingers being frequently compared to that given by a split pea, a term originally used by Benjamin Bell, in illustration of the size of the chancre itself. The induration of this form of chancre is very persistent, sometimes remaining long after the cicatrization of the ulcer. This form of chancre usually though not necessarily arises from a primary lesion of the same variety.

3. *The Phagedænic Chancre* is nothing more than either the superficial or deep chancre, attacked by phagedænic ulceration. If this extend so far as to pass the limit of induration, the case may be mistaken for one of phagedænic chancroid.

Characteristics of Chancre.—*Induration* is a characteristic feature of all forms of chancre, but I am hardly prepared to say that it is universally present. In the case of deep chancre it is very evident, and in the parchment-like form could probably be detected *at some period* in almost every case of superficial chancre, if the patient were constantly under observation. It may, however, in this form of chancre, be quite evanescent, and may, in either variety, disappear under the influence of phagedænic action. It must be distinguished from the inflammatory thickening and hardness which occasionally surround the chancroid, and this can usually be done by observing the sharply defined limitation of the true syphilitic induration (which gives exactly the sensation of the presence of a foreign body), and by observing the absence of the ordinary signs of inflammation. The microscopic characters of syphilitic induration are not very distinctive. Robin found fibres of areolar and elastic tissue, with fusiform cells, free nuclei, and amorphous granules, while Ordoñez observed hypertrophy of the normal structures, with inflammatory lymph, hemorrhagic effusions, round or oval nuclei, fusiform cells, and bundles of fibres in different stages of development. According to Auspitz and Unna, the epidermis undergoes a peculiar development, growing downwards in processes which send out lateral projections, these being subsequently isolated by the growing connective tissue. Induration is usually developed within a very few days after, and, occasionally, even *before*, the appearance of a chancre; it is rarely if ever manifested for the first time after three weeks. Sigmund, of Vienna, found that in 231 out of 261 cases, induration appeared from the 9th to the 14th day after *contagion.* The period during which induration persists is ordinarily from two to three months, and in some instances it lasts for many years.

A chancre is in most cases *solitary*, thus differing in a marked manner from the chancroid, which is commonly *multiple.* When two or more chancres coexist in the same patient, it will be found that they have arisen from multiple but simultaneous inoculation, and usually by contagion from secondary lesions.

The chancre is, under ordinary circumstances, *not auto-inoculable*; if, however, as is done by the advocates of syphilization, the chancre be irritated by savine ointment, etc., until its secretion becomes purulent, an ulcer may be indeed produced by auto-inoculation—but it is not proved that this ulcer is a chancre.[1] This fact (the non-auto-inoculability of chancre) appears to be owing to a property which syphilis shares with smallpox and many other affections, viz., that one attack of the disease protects a patient, for a time at least, from any subsequent infection. This protective influence extends through all the stages of syphilis, so that a second attack of syphilis, though possible, is very rare. Cases have been, indeed, recorded in which a chancre has apparently arisen after impure coitus, in a person at the time actually suffering from general syphilis; but, as shown by Fournier, the suspected chancre in these cases is really but a reulceration in the seat of the original primary lesion, which may be caused by any irritation, either constitutional or local—sexual intercourse being but one form of local irritation, though one which may easily give rise to confusion, particularly if the patient's partner in the venereal act should happen to be affected with any disease of the generative organs, whether syphilitic or otherwise.[2]

The *duration* of the chancre is self-limited; it heals without treatment in a period varying from a few weeks to several months, the only exception being probably in the case of the phagedænic variety. The primary and secondary periods of syphilis usually overlap each other, syphilitic erythema occurring, according to Bassereau, in about three out of four cases, before the chancre has completely healed. The *cicatrix* of a chancre is more or less depressed, according to the depth to which ulceration has extended. It is at first discolored, but subsequently becomes whiter than the surrounding skin. It is usually very persistent, and can often, though not always, be distinguished from the scar of a chancroid. Ricord first pointed out that a chancre, instead of undergoing cicatrization, might become converted into a *mucous patch*. This change may occur in any situation, but is most often seen where mucous tissues are habitually in contact, as the inside of the lips, the tongue, the inner surfaces of the labia, the folds of the anus, or the lining surface of the prepuce. The change occurs when the repair of the chancre has been nearly completed by granulation, and consists in the formation of a white membranous pellicle, which gradually spreads from the circumference of the sore to its centre. It is from inattention to this fact that a mucous patch has been in some cases supposed to be really the initial lesion of syphilis, the patient not being seen until the transformation has occurred, and the previous existence of a chancre thus escaping recognition.

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[1] It has been recently suggested that the ulcer which results from the auto-inoculation of a *chancre* is a *chancroid*, and that this tends to confirm the view of Clerc, that the latter lesion is a *derivative of the chancre*, or, in other words, the result of chancrous contagion in a person already syphilitic, just as *varioloid* is the result of the variolous poison acting upon a person already protected against smallpox; but the analogy fails, because varioloid is just as much a constitutional disease as variola itself, while the chancroid is a purely local lesion, and because the contagion of varioloid will communicate to an unprotected person not varioloid but smallpox, while the chancroid can only reproduce itself. Moreover, if the chancroid be a derivative of the chancre, the latter (and of course syphilis generally) must have existed before the affection which is its mere modification—an hypothesis which is contradicted by all that is known of the histories of the two affections. As a matter of observation, the ulcer derived from auto-inoculation of a chancre appears to be precisely such a sore as can be produced by inoculating a syphilitic subject with non-venereal matter.

[2] See Fournier, Archives Gén. de Médecine, Juin et Juillet, 1868.

Mixed Chancre.—It has already been stated that chancroid and syphilis may exist in the same patient. They may likewise be acquired at the same moment. Hence a patient, a few days after impure coitus, may present several venereal ulcers, not indurated and evidently not syphilitic—and yet in a few weeks, without further exposure, one of these may become indurated and be followed by secondary symptoms. The syphilitic has been inoculated simultaneously with the chancroidal poison, just as it may be inoculated with the poison of cowpox, the vaccine disease disappearing at the usual time, and syphilis following after its own proper period of incubation. Again, syphilis may be inoculated upon a previously existing chancroid, a chancre being the result; or conversely, if a person with chancre have sexual intercourse with a woman affected with chancroid, he may acquire the latter disease, his chancre serving as a point of inoculation. The term *mixed chancre* is, perhaps, an unfortunate one, as seeming to imply that the venereal ulcer to which it refers is intermediate between chancre and chancroid; the fact being that it is not in any degree intermediate, but a result of the accidental coexistence of two separate diseases.

Syphilitic Bubo.—Induration and chronic enlargement of the neighboring lymphatic glands are almost, if not absolutely, constant sequels of chancre. As in the large majority of cases the latter is situated on the genital organs, it is the inguinal glands that are usually affected, constituting the ordinary syphilitic bubo; but induration will attack the facial and submaxillary glands if the chancre be cephalic, and those of the elbow and axilla if the initial lesion occupy the finger. Cases have been recorded by H. Lee, and others, in which a chancre is said to have been followed by secondary symptoms, without the intercurrence of a bubo, and the *possibility* of such an event must therefore probably be acknowledged: such cases must, however, be extremely rare, and in no instance can it be fairly claimed that this has happened, unless the patient has been continuously under the notice of a skilled observer, as syphilitic bubo is often unperceived by the patient himself, and may, like the induration of a chancre, pass off in a comparatively short time.

The *development* of a syphilitic bubo coincides pretty closely with that of induration in the chancre which precedes it; it is *polyganglionic* and usually *bilateral*, or, in other words, involves the whole chain of superficial glands, and commonly invades both groins at once. The glands are hard, movable upon each other and beneath the skin, usually painless, and about the size of almonds (*amygdaloid* enlargement); one is frequently larger than those which surround it, the group being fancifully designated by French writers as the "*pleiade ganglionnaire.*" The syphilitic bubo has in itself *no tendency to suppurate*, and when suppuration occurs it is due to the influence of some external irritant, to the patient's being of a scrofulous diathesis, or to the coexistence of a chancroid. In the latter case, the suppurating bubo will be chancroidal, and its pus, of course, auto-inoculable. The *duration* of a syphilitic bubo is variable, lasting usually longer than the induration of the chancre, and being in many cases quite distinct for six months or a year after infection. Cases have even been recorded, by Venning and others, in which the amygdaloid condition of the inguinal glands persisted twenty years or longer; and it is believed by the above-named writer that the disappearance of this condition may be considered an evidence that the disease has worn itself out, and that the patient is susceptible of re-infection. The syphilitic bubo is often attended by *induration of the lymphatics* running from the chancre to the affected glands; resolution usually occurs about the time that induration disappears from the chancre, but, occasionally, suppuration has been observed, a number of fistulous openings being formed in the course of the vessel.

It is believed by some surgeons that a syphilitic bubo may occur without any pre-existing chancre, and this has been spoken of as a form of the *Bubon d'Emblée*. Such cases are, however, really instances of defective observation, or of voluntary deception upon the part of the patient. A superficial chancre may readily be unnoticed by a patient, or even by a surgeon, particularly if situated in the urethra, or neck of the uterus, or if unaccompanied by induration: there is no sufficient evidence to throw doubt upon the truth of the axiom, that *the initial lesion of syphilis is invariably a chancre.*

SECONDARY SYPHILIS.

Between the time of appearance of a chancre and the period at which *secondary symptoms* are developed, there is an interval which is sometimes called the *period of incubation* or *latency*. The former term is better applied to the interval between the date of contagion and that of the appearance of the chancre, while in many cases the disease cannot properly be said to be *latent*, as the chancre and attendant bubo frequently continue after the appearance of general syphilis, the primary and secondary stages often, as already remarked, overlapping each other. The shortest period in which an *untreated* chancre is known to have been followed by secondary symptoms is twenty-five days, while the *average period*, as shown by an analysis of nearly 500 cases, is about *six weeks*. Secondary syphilis rarely appears after the first three months, and almost never later than six months, unless the natural evolution of the disease has been interfered with by treatment. *Secondary syphilis cannot occur without primary syphilis having preceded it:*[1] the apparent exceptions are due to the primary symptoms having escaped detection, an event which, as already seen, may readily occur under various circumstances.

Premonitory Signs.—Certain premonitory symptoms usually precede the development of secondary syphilis, lasting from a few days to a week or more, and consisting in febrile disturbance, with languor and general discomfort, vague pains of a neuralgic character, headache, sometimes apparently neuralgic, but sometimes due to inflammation of the pericranium,[2] and (particularly in women) anæmia. With the exception of the pericranial headache, these symptoms usually disappear upon the occurrence of the eruption and other secondary symptoms. The most characteristic and usual manifestations of secondary syphilis, are cutaneous eruptions, sore throat, mucous patches, and general enlargement of the lymphatic glands. More rarely we find falling of the hair, certain affections of the eyes and ears, paralysis, and other symptoms referable to the implication of the nervous system.

Cutaneous Eruptions.—There is no definite syphilitic eruption. On the contrary, a large number of skin diseases may occur as manifestations of syphilis, and several of them are not unfrequently found coexisting in the same case. The limits of this work will not permit any extended description of the various syphilitic eruptions, or, as they are often called, *Syphilo-dermata* or *Syphilides*, for a full account of which I would respectfully refer the reader to the numerous excellent works on Venereal Diseases which have recently been published, and more especially to those of Cullerier, Lancereaux, and Belhomme and Martin, in France, of H. Lee and W. J. Coulson in England, and of Bumstead and Van Buren and Keyes in this country. Cazenave's classification is that usually adopted, those eruptions which belong to the secondary stage of syphilis being the *exanthematous* (erythema and roseola), the *papular* (syphilitic lichen), the *vesicular* (herpes, eczema, syphilitic varicella, etc.), the *bullous* (pemphigus and superficial rupia), and the *pustular* (ecthyma, acne, and impetigo). Syphilitic erythema is usually the earliest of the eruptions, and is frequently so slight as to escape the attention of the patient. Ecthyma is likewise an early manifestation of secondary syphilis, and is very often met with in the scalp. There are certain features which habitually mark all forms of syphilitic eruption, and which have a certain diagnostic value. These are (1) the so-called *protean* character of the eruption, or the appearance simultaneously, or in quick succession, of more than one variety; (2) the peculiar reddish-brown or copper-colored hue of the eruption in its declining stage; and (3) the absence of itching. Fournier has lately pointed out a peculiarity of the skin in syphilis, which he considers quite significant. This is cutaneous anæsthesia, of which he describes three varieties, viz., anæsthesia as regards pain, or *analgesia* (by far the most common), anæsthesia of general sensibility, and anæsthesia as regards changes of temperature.

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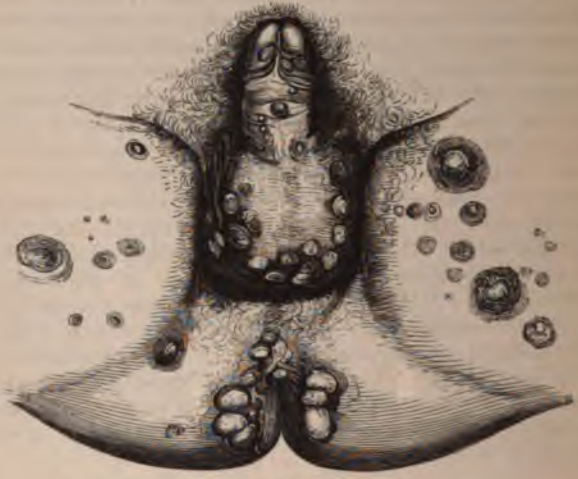
[1] This remark does not, of course, apply to *hereditary syphilis*.

[2] According to Mauriac, periostitis, whether of the cranium or other parts, is much more common as an early manifestation of syphilis among the Arabs in Africa, and the inhabitants of South America, than among the residents of other countries.

Sore Throat.—The sore throat of secondary syphilis may consist merely in erythematous efflorescence of the part, or in a superficial aphthous ulceration. This may affect the fauces, tonsils, palate, cheeks, or tongue. Occasionally, in this stage, the tonsil may present an excavated ulcer, with sharp-cut edges and sloughy surface, which somewhat resembles a chancroid, and has been incorrectly called an *amygdaline* chancre. The severer forms of syphilitic sore throat, with the concomitant affections of the larynx and œsophagus, belong to the tertiary period of the disease.

Mucous Patches.—These, which are also called *Condylomata*, *Moist Papules*, and *Mucous Tubercles*, are particularly interesting as being the manifestation of secondary syphilis which is chiefly concerned in the transmission of the disease, though it is probable that any of the moist forms of eruption may occasionally prove the source of contagion. Mucous patches occur on mucous membranes, or where the skin is thin, and particularly where two surfaces are habitually in contact. They are thus chiefly seen on the vulva, or around the anus, between the buttocks, on the scrotum, or on the penis; in the mouth, on the tonsils, lips, and tongue; and more rarely between the toes, on the inside of the thighs, and on other parts of the body. On the skin they appear as flat, slightly elevated papules, about half an inch in diameter, and covered with a slimy, fetid exudation. This appears as a kind of false membrane or pellicle, which covers a raw surface from which the cuticle has been previously removed. On the mucous membranes they are less elevated, and, in the mouth at least, the exudation takes the form of a whitish pellicle, constituting the so-called "opaline patch." Condylomata usually first appear as reddish spots, effusion taking place beneath the cuticle, which drops or is rubbed off, the surface being then soon covered with the characteristic exudation. Occasionally a chancre is directly transformed into a mucous patch, in the manner already described. Mucous patches produce a great deal of local irritation, and give much annoyance by their offensive odor. They often become ulcerated, and are occasionally confluent. At the angles of the mouth, on the tongue, and at the margin of the anus,

FIG. 197.



Mucous patches. (MILLER.)

they are apt to be fissured, in the latter situation constituting a form of what are known as *rhagades*.

Mucous patches are very frequently met with in either sex, but probably most often in women. They run a very chronic course, and are apt to recur at irregular intervals.

Urethral, Vaginal, and Uterine Discharges, without the existence of any recognizable ulceration, are, as pointed out by Hammond, Morgan, and H. Lee, occasionally met with as symptoms of secondary syphilis, and are probably more often the source of contagion than is commonly supposed.

Enlargement of Lymphatic Glands.—This is a very constant and significant manifestation of secondary syphilis. The glands most commonly affected are the posterior cervical, though others are occasionally involved. The cervical engorgement is most marked when a pustular eruption exists upon the scalp; this form of glandular enlargement is very different from the glandular induration observed in the primary stage, though, like that, it usually ends in resolution. The period of development of this characteristic symptom is, according to Bumstead, from six to eight weeks after the appearance of the chancre.

Alopecia, or Falling of the Hair, is an early symptom of secondary syphilis. It is sometimes so slight as to be scarcely recognizable, and is most marked when the scalp is the seat of an abundant eruption. Beside the hair of the head, the eyebrows may be affected, and more rarely the eyelashes and beard. This form of alopecia is amenable to treatment, and, according to Bumstead, is often absent when mercury has been taken in the primary stage. There is another form met with in connection with tertiary syphilis, which is usually incurable.

Affections of the Eye.—*Iritis* is not unfrequently met with during the secondary stage of syphilis, though the worst form of the affection is that which occurs in the tertiary stage. The latter, according to Gascoyen, is really due to syphilitic contamination, while the variety met with during the secondary stage, and to which Virchow gives the name of *serous iritis* or *peri-iritis*, results from accidental causes, beginning with congestion or inflammation of the conjunctiva, and involving the iris only secondarily. The vascular sclerotic zone around the margin of the cornea is not very well marked in this form of the disease, nor is pain a constant symptom. Nodules of lymph soon appear upon the iris, especially around the pupil, and the aqueous humor often becomes turbid; the cornea is occasionally involved. The pupil is sluggish and contracted (occasionally dilated), but there is little photophobia. Both eyes are often attacked, though usually not simultaneously. This form of iritis is much less intractable than the *parenchymatous* variety which occurs in tertiary syphilis. *Retinitis* and *Choroiditis* are occasionally met with in syphilis, usually as a concomitant or sequel of iritis; the symptoms consist of mistiness of vision, micropsia, and diminution of the visual field, with a feeling of fulness in the eye and some circumorbital pain, but without photophobia. It is sometimes possible, according to Wells, to distinguish these affections from those which are not syphilitic, by their ophthalmoscopic appearances, even if no other symptoms of syphilis are present. Syphilis is, according to Cowell, by far the most frequent cause of *diffuse neuro-retinitis* and *exudative retinitis*, which are the ordinary forms of the disease. The former is quite amenable to treatment, and is fortunately much commoner than the exudative variety. Syphilitic affections of the *lachrymal apparatus* have been recently described by R. W. Taylor, of New York.

Affections of the Ear.—Acute myringitis, or inflammation of the *membrana tympani*, sometimes occurs in secondary syphilis, and may cause permanent deafness from inflammatory thickening of the part. Dr. F. R. Sturgis has reported two cases of inflammation of the middle ear due to secondary syphilis, and syphilitic disease of the internal ear has been observed by Roosa and by Moos.

Affections of the Nervous System.—*Hemiplegia*, with or without loss of consciousness, often preceded by persistent *headache*, *mydriasis*, and perhaps *ptosis*, is occasionally observed in connection with the secondary stage of syphilis. The explanation of these cases (in which no appreciable lesion may be found after death) is, according to Dr. E. L. Keyes, of New York, who has paid particular attention to the subject, that the paralysis is due to general or partial congestion of the brain, analogous to the congestions of the skin and mucous membranes which occur in secondary syphilis.

Affections of Joints and Bursæ.—These may, according to Keyes, be affected in secondary syphilis, becoming congested and sometimes painful, though in other cases the congestion is painless and followed by effusion.

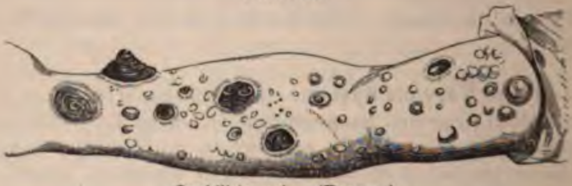
The various manifestations of syphilis which belong to the secondary stage occur with a certain degree of regularity (the exanthematous, for instance, usually preceding the papular eruptions), and last, with occasional intermissions, for a period varying from one to six months. They are *general* symptoms, that is, are met with in various parts of the body simultaneously, and tend to a spontaneous cure, leaving, as a rule, no traces to mark their course. In mild cases of syphilis, the disease appears to wear itself out in this stage, and tertiary symptoms are therefore by no means of invariable occurrence.

TERTIARY SYPHILIS.

After the subsidence of the secondary stage of syphilis, there is usually an interval before the development of tertiary symptoms. This interval is of no definite length, being in some cases of several years' duration, and the patient meanwhile being apparently quite well, while in other cases the third stage begins before the second is concluded, so that they absolutely overlap each other. Tertiary syphilis may affect almost any tissue or organ of the body, and the symptoms of this stage are developed with such irregularity as to render it impossible to classify them chronologically. The third stage of syphilis is called the stage of deposit, as it is marked by the deposit, in various parts of the body, of new material, which may take the form of a contractile lymph, leaving depressed cicatrices, or of a soft gummy substance, constituting the so-called gummatous syphilitic tumors. We may consider successively the manifestations of tertiary syphilis, in the skin, mucous membranes, eyes, solid viscera, nervous system, areolar tissue, muscular and fibrous tissues, and bones and periosteum.

Skin.—The chief cutaneous manifestations of tertiary syphilis are the *tubercular* and *squamous eruptions*, together with a destructive form of *rupia*. *Syphilitic Tubercles*, which may be either *dry* or *ulcerated*, occur most often on the face, especially about the lips and nose, where they occasionally produce great disfiguration. They begin as small, solid, cutaneous tumors, of a dusky-red color, and with a firm base, and are frequently developed in connection with the hair-follicles. They are often aggregated in a circular form, and, if resolution occurs, leave depressions in the skin, which, though at first copper-colored, ultimately become white and scar-like. The ulcerated syphilitic tubercle occasionally produces great ravages, and may be mistaken for lupus, rodent ulcer, or serpiginous chancroid. It heals with a characteristic white and depressed cicatrix, if the ulceration have extended deeply, or with a thin and shining scar, if superficial. The *squamous eruption* assumes the form of *Psoriasis*, *Pityriasis*, or *Lepra*. Syphilitic psoriasis often attacks the palmar and plantar surfaces, and the eruption is in these situations very characteristic of the nature of the disease; palmar or plantar psoriasis may be attended with cracks and fissures, which cause a good deal of irritation and interfere with the functions of the part. The late form of *Rupia*, which occurs in connection with tertiary syphilis, differs from that seen in the secondary stage merely in the greater depth to which ulceration

FIG. 198.



Syphilitic rupia. (DRUITT.)

extends. In this stage a severe form of *Alopecia* is occasionally seen, in which the hair-follicles all over the body may be destroyed, the affection being, of course, incurable; this variety of alopecia usually occurs in connection with the tubercular eruption already described. *Syphilitic Onychia,* or ulceration in the matrix of the nails, which become dry and distorted, and are finally thrown off, is a concomitant of the squamous eruptions, and affects the hands more often than the feet.

Mucous Membranes.—The *tongue* is often affected in tertiary syphilis; it may present *white patches* upon its surface, apparently due to lymphy deposit and opacity of the epithelium, upon the detachment of which a smooth and slightly depressed spot remains—or there may be a tubercular condition of the tongue, analogous to that described as affecting the skin, which may end in ulceration, or may assume the form of a deep-seated lymphy deposit, causing stiffness, contraction, and distortion of the organ. The ulcerated form of lingual syphilis may cause great destruction of the part, and has been mistaken for *epithelioma:* the latter affection attacks particularly the side of the tongue, is solitary, and involves the submaxillary ganglia; while the *lingual syphilitic tubercle* is commonly multiple, occupies the dorsum and base of the tongue, and is not attended by enlargement of the lymphatic glands.

The *tonsils, fauces,* and *palate* suffer in tertiary syphilis from ulceration, which may be circumscribed or phagedænic. The latter variety usually results from the ulceration of syphilitic tubercle, and may produce very wide destruction of parts, involving the soft palate and uvula, pillars of the fauces, and orifices of the Eustachian tubes, and causing difficulty of swallowing, with perhaps regurgitation through the nostrils, deafness, and difficulty of articulation. The discharge is very offensive, and the ulceration may extend to the nose, larynx, or œsophagus, or may even involve the cervical vertebræ.

The *larynx* and *trachea* may be affected with a deposit of syphilitic tubercle, which may undergo ulceration, causing dyspnœa, often of a paroxysmal character, and perhaps requiring tracheotomy for its relief. Contraction of the windpipe may occur, constituting tracheal stricture, or the voice may be permanently impaired by alterations of the vocal cords.

The *pharynx* and *œsophagus* may be the seat of syphilitic ulceration, and œsophageal stricture may result after cicatrization. The *colon* may be, according to Paget, affected in tertiary syphilis with a form of ulceration analogous to the ulcerated tubercle of the skin. Cullerier has described a *syphilitic enteritis,* which he considers analogous to the erythema of the skin, and as therefore belonging to the secondary period; his views upon this point, however, are not generally accepted. The *rectum* may become ulcerated in tertiary syphilis, giving rise to a troublesome form of stricture in that part.

The *urethra* may be involved in tertiary syphilis, and H. Lee believes that many cases of stricture are of syphilitic origin.

Eye.—The worst form of syphilitic *iritis* is that which occurs during the tertiary stage. In this variety of the disease the iris is primarily attacked, but in an insidious and almost painless manner, becoming the seat of a deposit of yellow tubercles, which are shown by the microscope to be identical in structure with the gummatous tumors found in other parts of the body. The deeper-seated structures are occasionally involved, permanent disorganization being then apt to occur, though Dr. Rankin, of New York, has reported a remarkable case of syphilitic *atrophy of both optic nerves,* cured by large doses of mercury, strychnia, and iodide of potassium. R. W. Taylor reports cases of tertiary, as well as of secondary, syphilitic disease of the *lachrymal apparatus*, while C. S. Bull has observed *optic neuritis* and *paralysis of the ocular muscles* as a result of syphilis.

Solid Viscera.—Visceral syphilis has, until recently, not attracted as much attention as it deserves. Among the organs (apart from those of the nervous system) in which syphilitic lesions have been observed, may be particularly mentioned the testis, liver, spleen, kidneys, mesenteric glands, lungs, and heart. The limits of this work will not permit a description of the changes produced by syphilis in any of these viscera, except the testis; and, indeed, syphilis of the internal organs is habitually treated by the physician rather than by the surgeon. For a full account of these affections I would refer the reader to the work of Lancereaux, which has been translated for the New Sydenham Society, and which gives a very complete account of visceral syphilis.

Syphilitic Sarcocele, or *Syphilitic Orchitis*, appears under two forms, the interstitial and the circumscribed or gummy. *Interstitial Orchitis* occurs in the early part of the tertiary stage, and is attended with the formation of a contractile lymph, which occupies the trabeculæ of the testis, rendering the organ hard and dense, and sometimes eventually leading to its atrophy. One testis only is usually affected, becoming somewhat enlarged, but painless, and giving annoyance only by its weight. Hydrocele often accompanies this form of the disease, which is very chronic, and rarely followed by suppuration. The *Circumscribed* or *Gummy Orchitis* was first described by Hamilton, of Dublin, as *Tubercular Syphilitic Sarcocele*. In this variety, numerous masses of a yellowish-gray color are deposited in various parts of the testes, both of which are usually affected. These masses, at first firm, undergo softening, with fatty or cretaceous degeneration, and not unfrequently lead to suppuration, with the formation of fistulous openings, and occasionally a fungous protrusion of the testicle itself. Under the microscope, these yellowish masses are found to differ from ordinary lymph, in containing a large amount of cells and fat globules, with crystals of margarine. The *ovary* is occasionally affected in tertiary syphilis in a similar manner to the testicle.

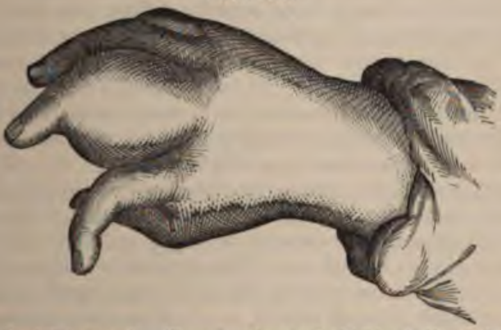
Nervous System.—The *brain* and *spinal cord* suffer in tertiary syphilis, deposits of a lymphy or gummy nature taking place in the substance of those organs, or in their membranes, and giving rise to various nervous disturbances, such as *Epilepsy*, *Paralysis* (which may be local or general), *Chorea* (a rare manifestation of syphilis of which Dr. R. H. Alison has collected four cases), *Mental Perturbation*, or, as pointed out by M. H. Henry, absolute *Dementia*. *Diabetes* is said to have resulted from syphilitic disease of the base of the brain. The credit of first distinctly recognizing the existence of syphilitic lesions of the central nervous system is due, I believe, to Reade, of Belfast, Ireland, whose first paper was written in 1847, though not published till some years subsequently. The subject has since then received a good deal of attention, and elaborate memoirs have been written on syphilitic affections of the nervous system by several authors, especially by Lagneau, the younger, and Zambaco, to whose works the reader is respectfully referred. A few cases are on record in which syphilitic deposits have been found in the *nerves*, as well as in the nerve-centres.

Arteries.—The occurrence of arterial degeneration as a result of syphilis has long been recognized, but the change has been supposed to be identical with atheroma. According to Heubner and Ewald, however, it differs from that condition in affecting exclusively the smaller arteries, and in having no tendency to gelatinoid or cartilaginoid change, or to fatty or calcareous degeneration. The syphilitic change, according to these authors, consists in the formation of a new growth of the connective tissue type, occupying the inner coat of the vessel, and formed by nuclear proliferation of the cells of the epithelial lining. If so large as to occlude the artery, thrombosis occurs and is followed by atrophy of the vessel.

Areolar Tissue.—The subcutaneous and submucous areolar tissues are the favorite seats of the so-called *gummy* or *gummatous* deposits of tertiary syphilis. These usually occur as hard, round, indolent, subcutaneous nodules, which gradually undergo softening and become adherent to the skin; ulceration finally takes place, and, after the extrusion of a slough, the part heals, leaving a depressed scar which is at first purple, but subsequently becomes white. When cut open, these nodules or gummatous tumors present a tolerably firm cystic investment, containing a semi-solid gelatinous or *gummy* substance, whence their name. Their size varies from a half inch to two or more inches in diameter, and they are usually solitary, occurring at successive intervals, though occasionally multiple. They are chiefly seen upon the extremities and upper part of the trunk. Under the microscope, they are found to consist principally of fibres, granules, and nucleated cells, with a few elastic fibres, free nuclei, and capillary bloodvessels. When situated in the *submucous tissue*, gummata give rise to troublesome ulcerations, and cause some of the most intractable forms of syphilitic sore throat. They are also met with in the submucous tissue of the genito-urinary organs in both sexes.

Muscular and Fibrous Tissues; Bursæ.—*Gummatous Tumors* occur in the voluntary muscles, tendons, and fasciæ, interfering with the functions of the parts, and sometimes causing deep and painful ulcers. They may also, according to Keyes, affect the bursæ, either primarily or by extension from other tissues. In the fingers and toes, in which situations they may involve either the superficial tissues, or the periosteum and bone (when disorganization of the joints may follow), they give rise to the troublesome condition known as *Syphilitic Panaris or Whitlow*, or *Syphilitic Dactylitis*, the latter name being preferred by Taylor, of New York, who has given an excellent account of the affection. (See Fig. 199.) Ricord and others state that syphilis may cause *rigid muscular contraction* (as of the biceps), without

Fig. 199.



Syphilitic panaris. (From a patient at the Children's Hospital.)

organic change. The so-called congenital tumor of the sterno-mastoid muscle appears in some cases to be a syphilitic lesion.

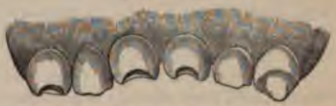
Bones and Periosteum.—*Periostitis* is of frequent occurrence in tertiary syphilis, and the periosteum of those bones which are subcutaneous is most often affected, as of the tibia, cranial bones, clavicle, sternum, radius, and ulna. *Osteocopic* (literally, *bone-tiring*) pain is often observed long before any other symptom, and, in a large majority of cases, has the peculiarity of being aggravated by the warmth of bed. Syphilitic periostitis is usually circumscribed, and gives rise to the formation of oblong swellings, called *nodes*, which are commonly hard and indolent, being due to lymphy deposit in and beneath the periosteum, but which in other cases are fluctuating and tender, and apparently due to the deposit of gummatous material. They may often be dispersed by treatment, but occasionally persist, becoming converted into exostoses. Suppuration rarely occurs, unless the bone itself be involved. Syphilis affects the *bones* by producing chronic *osteitis*, leading to hypertrophy and induration, or to *caries* and *necrosis*. These may affect any bones, but are most frequent in the jaws and skull—either the vault or base, but, according to H. Allen, rarely both together—and sometimes lead to destruction of the hard palate, falling in of the nose, or grave cerebral disturbance. Syphilitic necrosis may, according to Virchow, be recognized by observing that the sequestrum has a perforated and worm-eaten appearance, which he attributes to the previous existence of gummy matter in the part. A peculiar form of *dry caries* is described by the same writer, as due to the pressure of a gummy tumor, leading to inflammatory atrophy without suppuration. Two such cases are referred to by Erichsen, both occurring in the head of the tibia.

HEREDITARY SYPHILIS.

The natural history of this form of syphilis differs from that of the acquired variety, chiefly in having no primary stage. A fœtus may be infected in several ways: (1) the mother may be the subject of secondary or tertiary syphilis, the father being healthy; (2) both parents may be syphilitic, when the disease will probably be inherited in a worse form than if one alone be affected; (3) the mother may be healthy at the time of conception, but may acquire syphilis during pregnancy, and transmit it to her offspring; and (4) the father may transmit the disease to the fœtus, without directly infecting the mother, who, however, may in turn be infected by the embryo. The latter mode of transmission is denied by many authors, and is certainly of rarer occurrence than the others. The syphilitic embryo very often dies before the full term of intra-uterine life is accomplished, and abortion then follows. Occasionally, though rarely, a child presents mucous patches and other unmistakable evidences of syphilis at the moment of birth, and the disease is then properly called *congenital*. More often, however, the child is apparently healthy when born, or, if cachectic, presents no definite morbid lesions. Hereditary syphilis is usually developed from a fortnight to two months after birth, but may appear at any time within the first year. It is very doubtful whether the first manifestation of hereditary syphilis ever occurs at a later period, the apparent exceptions which have been reported being probably cases of acquired syphilis, or, if of the hereditary form of the disease, cases in which the early symptoms have been overlooked.

The early manifestations of hereditary syphilis belong to the secondary period of the disease, those which are most characteristic being mucous *patches*, *syphilitic pemphigus*, and *coryza*—the *snuffles* of the popular vocabulary. *Laryngitis* may also occur in this stage, with inflammation of the buccal mucous membrane, or syphilitic *stomatitis*. If the latter exist, the *temporary teeth* are apt to be ill-formed and carious, and often drop before the usual time. The child becomes sallow and withered, and seems prematurely old. If death do not occur from malnutrition during this stage of the disease, there is usually a lull in the symptoms, the later manifestations (which belong to the tertiary period) not being developed until after the fifth year, and usually about the age of puberty. The most characteristic signs of hereditary syphilis, in this stage, are *interstitial keratitis*, linear *cicatrices at the corners of the mouth*, and a peculiar *notched condition of the permanent teeth* (Fig. 200), particularly of the upper central incisors, first pointed out by J. Hutchinson. *Interstitial keratitis* usually affects both eyes, and is attended with a formation of lymph between the laminæ of the corneæ, which often remain permanently opaque in spots. *Iritis* is much rarer in the hereditary, than in the acquired, form of the disease. Inflammation of the *choroid*[1] and *optic nerve*, and *deafness*, are also sometimes observed as a result of hereditary syphilis. The *viscera* affected in these cases are chiefly the liver and lungs, the brain and thymus gland being more rarely involved. The *bones* may be affected in hereditary syphilis, the lesions particularly deserving attention being the *syphilitic panaris* or *dactylitis* (p. 461), and a peculiar inflammatory condition of the epiphyseal extremities of the bones, sometimes attended with suppuration and caries, and, from the loss of function which attends the disease, called by Parrot the *pseudo-paralysis of inherited syphilis*.

FIG. 200.



Syphilitic permanent teeth. (HUTCHINSON.)

A person who is the subject of hereditary syphilis is in a great degree, if not altogether, protected from syphilitic contagion in after-life, this being another proof of the essentially constitutional nature of the disease. *Acquired infantile syphilis* does not present any marked difference from the same disease as observed in the adult.

DIAGNOSIS OF SYPHILIS.

I have dwelt at length upon the natural history and morbid anatomy of syphilis, because it is only by means of a thorough comprehension of these that the surgeon is able to recognize and attach due significance to the various symptoms of the affection—these symptoms being often developed with apparent irregularity, and being constantly modified by previous treatment, or by various extraneous circumstances. In the diagnosis of most diseases, great assistance can often be obtained from the patient, who, if ordinarily intelligent, can usually give a more or less complete history of his own case; but in syphilis, very little reliance can be placed upon the statements of the patient. Apart from wilful deception, or concealment, to which there is of course unusual temptation in many cases of syphilis, there is another difficulty, which is that, the symptoms being spread over a term of years, and often in themselves trivial, the patient either does not notice them, or subsequently forgets their existence, and thus, with every intention of honesty, is constantly apt to mislead the surgeon by giving erroneous answers to such questions as are propounded. The most important point for consideration with reference to the diagnosis of *primary syphilis*, is the mode of distinguishing the *chancre* from the *chancroid*. It is by no means always easy, or even possible, to make this diagnosis without careful and repeated observation: the surgeon must in fact rely more upon the *natural history* of the disease, than upon the symptoms presented at any one period. The diagnostic marks between chancre and chancroid may be conveniently presented in parallel columns:—

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[1] Dr. C. S. Bull has seen syphilitic iritis and irido-choroiditis within a few hours of birth, the affection then being properly called congenital.

Chancroid.	**Chancre.**
No period of incubation; the sore is fully developed from four to six days after exposure. Usually multiple, if not at first, becoming so subsequently by auto-inoculation.	A distinct period of incubation; sore appears from one to seven (usually three) weeks after exposure. Usually solitary, and, when multiple, is so from the first; very rarely, if ever, by auto-inoculation.
An excavated ulcer, with sharply-cut, punched-out edges, a gray sloughy surface, and furnishing a copious auto-inoculable pus. Not adherent to subjacent tissue.	A superficial erosion, or an ulcer with hard, elevated, sloping edges, scooped out surface, and furnishing a scanty, serous, usually non-purulent secretion. If an ulcer, adherent to subjacent tissue.
No induration unless from extraneous causes, and then merely temporary inflammatory engorgement.	Peculiar, persistent, non-inflammatory induration, often parchment-like in character.
Little or no tendency to heal; often spreads, and liable to become phagedænic. Bubo not usual, and, when present, commonly monolateral and monoganglionic; apt to suppurate, and, if it do so, the resulting ulcer usually chancroidal.	Tends to heal spontaneously, and rarely becomes phagedænic. Bubo almost invariable, bilateral, polyganglionic, indurated, and indolent; rarely suppurates, and does not furnish auto-inoculable pus.
A strictly local disease, never producing systemic infection, and one attack affording no protection against subsequent contagion.	A strictly constitutional disease, systemic infection being present from the first, and manifesting itself by definite symptoms, usually from six weeks to three months after the appearance of the chancre. One attack usually protects from subsequent contagion.

Beside the information derived from observation of the patient, valuable aid in forming a diagnosis may be sometimes derived from *confrontation* and *inoculation*. *Confrontation* consists in examining the person from whom the disease has been contracted, and its value depends upon the fact that chancroid can only produce chancroid, while syphilis can only be imparted by a syphilitic lesion. It is in many cases, from obvious reasons, impossible to make use of confrontation, but, when available, it is a diagnostic means of great value.

Inoculation of either chancroid or chancre, should never be practised except upon the patient's own person; if the suspicious sore be a chancroid, inoculation will produce another chancroid, while if it be a chancre, the result will almost invariably be negative—unless the original sore have been first irritated by treatment, when inoculation may indeed produce an ulcer, though not, probably, one of a chancrous nature (see p. 452).

Microscopic examination has been employed by Biesiadecki as a means of distinguishing chancroid from chancre. Sections of a chancroid present appearances identical with those of simple ulceration, while in chancre the interior of the bloodvessels and lymphatics is packed with white cells, thus accounting in some degree for the characteristic induration.

It is often possible to declare a sore to be a *chancroid*, when yet it would not be safe to assert positively that symptoms of *syphilis* will not follow, for (1) the patient may have acquired both diseases simultaneously—in which case he may have what is called a *mixed chancre*, or may have a genuine chancroid on the genital organs, and a chancre (derived perhaps from a secondary lesion) elsewhere, as, for instance, in the mouth; or (2) he may have acquired syphilis in some previous exposure — the disease remaining latent until excited to activity by the fresh irritation produced by the chancroid, which, in such a case, would naturally appear to the patient to be the actual cause of syphilitic infection.

Chancre may occasionally have to be diagnosticated from *cancer*, *epithelioma*, or similar affections. This is particularly the case when chancre occurs in unusual situations, as on the fingers, lips, or tongue. The syphilitic nature of the disease may usually be recognized by observing the *early* implication of the neighboring lymphatic glands, and the effect of anti-syphilitic treatment, which should always be tried before resorting to operative measures in any doubtful case.

Syphilitic Bubo is not likely to be mistaken for any affection except *chronic scrofulous adenitis*. If there be no concomitant signs by which the nature of the case may be revealed, the surgeon should avoid giving mercury until the development of secondary symptoms.

Diagnosis of Secondary and Tertiary Syphilis.—Here the surgeon must rely not upon any one or two symptoms, but upon the coexistence of a number, and especially upon their course and order of development; in other words, he must rely upon careful clinical observation and his general knowledge of the natural history of the disease. A surgeon meeting with a case of iritis, or of cutaneous eruption, or of periosteal rheumatism, in a person of notoriously lax morality, should not at once jump to the conclusion that the disease is probably syphilitic; for to do so would be as unphilosophical as it might be unjust. If, on the other hand, a patient should suffer from frequent attacks of recurrent iritis, copper-colored eruptions of various forms, post-cervical engorgement, alopecia, and occasional development of mucous patches; or from osteocopic pains, indolent nodes, and gummatous tumors of the areolar tissue—even though such a patient should appear as virtuous as Joseph, or as wise as Penelope—the surgeon might reasonably conclude that he had to deal with a case of syphilis, and should direct his remedies accordingly. The diagnosis may often be assisted by observing the traces of past manifestations of the disease, such as induration of the genital organs, or of the inguinal glands, or the depressed white cicatrices of syphilitic ulceration. The *seat* of ulceration is often in itself significant. Leg ulcers which are not syphilitic, are almost always found below the middle of the calf, and any ulcer of obscure origin, situated at a higher point, may accordingly be looked upon with suspicion.

Finally, the diagnosis of syphilitic affections of the *viscera*, or *nervous system*, in the absence of external manifestations, can often be merely conjectural. Light may, however, often be thrown upon such cases, by noting the effect of anti-syphilitic treatment.

PROGNOSIS.

Syphilis, as seen at the present day, is certainly a milder affection than formerly. This is apparently due chiefly to the tendency which it shares with other diseases,[1] to become less virulent by frequent transmission. A considerable number of persons—more than is commonly supposed—are, besides, at least partially protected by inheritance. Moreover, as surgeons more generally understand the natural history of the affection, their treatment has become more judicious; and the reckless use, or abuse, of mercury, which was formerly so common in cases of syphilis, and which undoubtedly exercised an untoward influence on the course of the disease, has now given way to a more moderate and philosophical employment of this powerful remedy.

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[1] A familiar example is the vaccine disease, which is more violent when produced by matter fresh from the cow, than when transmitted from arm to arm in the ordinary way.

In any individual case, the prognosis will depend upon several circumstances. Infection from a deep (Hunterian) or from a phagedænic chancre, will probably give rise to a worse form of the disease than would be acquired from contact with secondary lesions. A deep chancre usually indicates a graver infection than a superficial erosion. If a patient be of a strumous constitution, or broken down by previous illness, or of dissipated habits, the prognosis will, other things being equal, be less favorable than in the case of one who is robust, and who will probably take due care of his health during the course of treatment. According to Sigmund, syphilis acquired in advanced life runs a milder course than in younger persons. Secondary symptoms will almost invariably occur in every case of syphilis, but in a mild case will probably declare themselves at a later period, will be less intense, and will be more evanescent, than in one which is severe. Again, the form of the first eruption is of prognostic value, an erythema, or roseola, indicating a milder form of syphilis than one of the other varieties. When the tertiary stage has once appeared, the chances of complete recovery become very doubtful; though the disease, however, can rarely, under these circumstances, be entirely eradicated, its manifestations may, in most instances, be, by judicious treatment, held more or less in check, and life prolonged with considerable comfort to the patient. Death from acquired syphilis is rare.

The prognosis of *hereditary syphilis*, if properly treated, is usually favorable as regards life, unless the disease be manifested at the time of, or very soon after, birth, when a fatal result may be feared.

TREATMENT OF SYPHILIS.

Treatment in Primary Stage.—As syphilis is a constitutional disease, it is to be met principally by constitutional treatment. The most valuable anti-syphilitic remedy is unquestionably mercury, the next in value being probably the iodide of potassium.[1] It is believed by most authorities that not only do the primary manifestations of syphilis disappear more quickly when mercury is given, than when it is withheld, but that the development or evolution of secondary symptoms is, if not prevented, at least retarded and favorably modified by the administration of the remedy during the primary stage. Prof. Bumstead and others believe, however, that, upon the whole, those cases do better in which mercury is withheld until the onset of the secondary stage, and hence only use this drug for primary syphilis in exceptional cases. My own opinion is that, while there can be no doubt that a chancre will heal under local applications alone, yet that, if the nature of the sore be well marked, and particularly if it be accompanied by the characteristic syphilitic bubo, it is, on the whole, safer to give mercury, taking care, of course, to guard against salivation, and discontinuing the remedy if it appear to irritate the patient's system. If, however, there be the slightest doubt as to the nature of the sore, or if the general condition of the patient be such as to contra-indicate the use of mercury, it is much better to rely upon local measures, giving only tonics or such other medicinal agents as may be required by the particular exigencies of the case. For primary syphilis, mercury is, perhaps, best given by the mouth, and the preparation which I prefer is the protiodide (hydrargyri iodidum viride of the U. S. Pharmacopœia), which may be conveniently combined with opium, as in the following formula: ℞. Hydrarg. iodid. virid. gr. iij–iv; Ext. opii gr. ij; Confect. opii ℈j. M. Div. in pilul. No. xij. Sig. One three times a day. This combination may often be used for many weeks, or even a longer time, without salivating, purging, or producing any other disagreeable effect. It should be discontinued as soon as any tenderness of the gums is perceived.

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[1] The *modus operandi* of these drugs is still a matter of dispute; perhaps we may come nearest the truth in saying that they probably act by promoting elimination and absorption—elimination of the syphilitic virus, whatever that may be, and absorption of the lymphy and gummy deposits which characterize the later manifestations of the disease.

With regard to the *Local Treatment* of chancre, all that can be done is to keep the part clean and free from sources of irritation, hastening cicatrization, when healing has begun, by occasional light touches with nitrate of silver. There is no advantage to be gained by attempting to destroy the indurated base of the sore by cauterization, for there is every reason to believe that systemic infection has taken place at or before the first appearance of the chancre. Excision is recommended by some authors, and may be resorted to under exceptional circumstances: thus if, in a case of phimosis, a chancre were situated at the extremity of the prepuce, circumcision would be justifiable, though it could hardly be expected to exercise any curative influence over the course of the disease. If a chancre be attacked with *phagedæna*, advantage may be derived from the use of opium, and of the potassio-tartrate of iron, both locally and generally, with free stimulation, if the condition of the patient require it. Mercury may be given cautiously, and, as it were, tentatively, being discontinued if the phagedænic action continue to spread under its employment. Cauterization with nitric acid, which, it will be remembered, is the great remedy for phagedænic chancroid, is rarely needed in the treatment of phagedænic chancre. If the surgeon suspect the existence of a *mixed chancre*, he should treat the case as one of simple chancroid, until the syphilitic nature of the affection becomes evident. Cauterization with nitric acid will, in such a case, be required under any circumstances, and little or no harm will result from delaying the use of mercury until the diagnosis has been rendered positive.

But little can be done for the treatment of *Syphilitic Bubo:* attempts may be made to promote resolution by pressure, or by the employment of discutient applications, though the latter should be used with great caution, lest they induce suppuration. Pressure may be conveniently applied by means of a compressed sponge and spica bandage, or by means of a suitable truss. If the patient remain in bed, a weight, or bag of shot, may be simply laid upon the groin. Inunction with mercurial or iodine ointment, combined with the ointment of hyoscyamus, or of stramonium, may sometimes be advantageously employed; or the part may be simply covered with mercurial plaster, or even with the ordinary soap plaster. I have sometimes observed benefit from the application of tincture of iodine, around, but not over, the enlarged glands, in the way recommended by F. Jordan. An Austrian surgeon, Dr. Jakubowitz, recommends injections with a hypodermic syringe of a solution of iodide of potassium (℞. Potass. iodid. gr. xv, Tinc. iodin. gtt. v, Aquæ f℥j. M.). If suppuration occur, troublesome sinuses will probably be left, which must be treated on the general principles laid down at page 394; while if, as is often the case, the patient give evidence of struma, mercury must be abandoned, and iodine and cod-liver oil substituted.

Secondary Stage.—By the course of treatment above described, it is possible, though not probable, that the development of secondary symptoms may be prevented. In *Secondary Syphilis* the use of mercury is generally acknowledged to be proper, though, even here, its employment will occasionally be forbidden by the constitutional condition of the patient, or by injurious consequences having resulted from its incautious or too prolonged administration during the primary stage of the disease. An important rule to be remembered in the use of mercury, in all stages of syphilis, is that the drug should be very gradually introduced into the system, and that salivation should be carefully avoided.[1] In the secondary stage, *mercurial inunction* is, I think, preferable to the internal administration of the remedy; half a drachm of mercurial ointment, or, which Berkeley Hill prefers, an ointment containing twenty per cent. of the oleate of mercury, may be slowly rubbed into the inner part of the thighs, once a day (the hand being covered with a soft leather glove, soaked in fat to prevent absorption, if the treatment be carried out by an attendant), or into the soles of the feet, as recommended by Coulson, in which case woollen socks should be constantly worn. In infantile cases, a few grains of the ointment may be smeared upon a strip of flannel, which is then applied as a belly-band. In many cases the use of inunction is objected to by the patient, and, under such circumstances, various preparations of mercury may be given *by the mouth*, the best probably being the corrosive chloride, in doses of from one-sixteenth to one-eighth of a grain, three times a day, after meals. It is best given in solution, much diluted, and may be conveniently combined with the bitter tonics, with the muriated tincture of iron, or (dissolved in ether) with cod-liver oil. The following formulæ, the second and third of which are imitated from Bumstead, will usually prove satisfactory:—

℞. Hydrarg. chlorid. corrosiv. gr. j; Tinct. gentian. comp. f℥ij; Syr. zingiberis f℥j; Aquæ f℥v. M. Sig. Tablespoonful three times a day.

℞. Hydrarg. chlorid. corrosiv. gr. vj–viij; Tinct. ferri chlorid. f℥j. M. Sig. Ten drops for a dose, in water.

℞. Hydrarg. chlorid. corrosiv. gr. i–ij; Etheris fʒj; Ol. morrhuæ f℥viij. M. Sig. Tablespoonful for a dose, in the froth of porter.

The red iodide of mercury is also a good preparation, in cases of secondary syphilis, and may be given in combination with the iodide of potassium, in doses of one-sixteenth of a grain of the former to eight or ten grains of the latter remedy.

Mercurial fumigation may be employed in obstinate cases of cutaneous syphilis, and is the method preferred by Langston Parker and H. Lee. The patient being enclosed in a suitable framework, covered with oil-cloth, steam is introduced, together with the fumes derived from the slow volatilization of a drachm or two of calomel, or of the red oxide of mercury, by means of a tin plate heated with a spirit-lamp, or, which is perhaps better, by means of the ingenious apparatus devised by the late Dr. Maury, of this city (Fig. 201).

The use of mercury by *hypodermic injection* has been of late successfully resorted to, in cases of syphilis, by Lewin, of Berlin, R. W. Taylor, of New York, and others, and this mode of exhibiting the drug may be employed when other methods are for any reason contra-indicated. From one-twelfth to three-eighths of a grain of the corrosive chloride, dissolved in 15 minims of water, or, which Staub prefers, in a chlor-albuminous solution, made with muriate of ammonium, common salt, and white of egg,[1] may be injected once or twice daily; or Bamberger's peptonized solution, which contains the bichloride and common salt; or, which is preferred by Ragazzoni, half a grain of the biniodide, dissolved with a little iodide of potassium in half a fluidrachm of distilled water. Pick and Streitz employ a preparation known as "iodo-pepton," which is a peptonized solution of the corrosive chloride with iodide of potassium. Either of these methods I should consider upon the whole better than the injection of calomel, suspended in a mucilage of acacia, as recommended by the Italian surgeons Pirochi and Porlezza.

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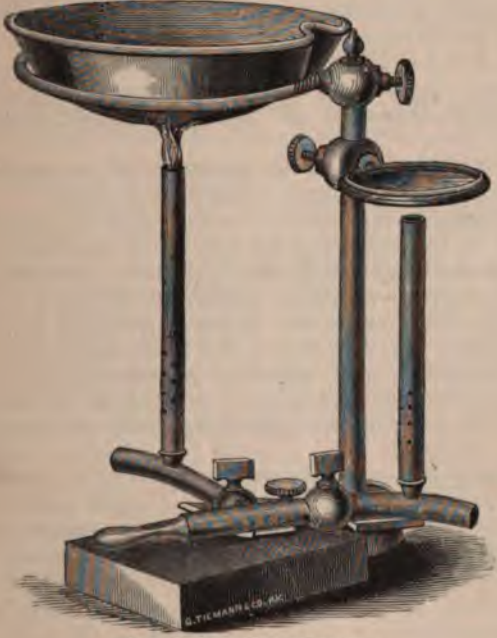
[1] Dr. Keyes, of New York, has shown, by actual counting, that small doses of mercury absolutely increase the number of red corpuscles both in healthy persons and in the subjects of syphilis.

FIG. 201.


G. TIEMANN & CO. N.Y.

Maury's fumigating apparatus.

Should *Salivation* occur during the administration of mercury, the remedy must be stopped, and astringent and detergent mouth-washes freely employed. The treatment may be subsequently cautiously resumed, or the iodide of potassium may be used instead. The occurrence of *Mercurial Eczema*, which, however, is rarely produced by the doses of mercury employed at the present day, would, also, of course, require the discontinuance of the remedy.

The *Local Treatment* of secondary syphilis is sufficiently simple. The irritation produced by *Mucous Patches*, may be relieved by the application of nitrate of silver, or, which I prefer, the solution of nitrate of mercury, with black-wash as an after-dressing. Conradi and Charon recommend the use of nitrate of silver, followed instantly by the application of metallic zinc.

Syphilitic Sore Throat may be treated with chlorate of potassium gargles, or with caustic applications, if there be any phagedænic tendency. The use of dilute muriatic acid, by means of the *atomizer*, may occasionally be advantageously resorted to.

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[1] Staub's solution may be made according to the following formula:—

℞. Hydrarg. chlorid. corrosiv., Ammonii muriat., āā ℈j; Sodii chlorid. ʒj; Aq. dest. f℥iv. Misce et cola, deinde adde Ovi alb. no. j, Aq. dest. q. s. pro f℥iv. Of this solution 15 minims, containing about $\frac{1}{12}$ grain of the sublimate, may be injected twice daily.

Iritis demands the unsparing instillation of atropia. The great risk is from occlusion of the pupil, and, in this affection, the local is even more important than the general treatment. With regard to the use of mercury for syphilitic iritis, I do not, in ordinary cases, recommend it, unless it be required for other syphilitic manifestations. The plan of treatment which I prefer is that recommended by Carmichael, which consists in the administration of drachm doses of the oil of turpentine, in addition to which may be given (in the iritis of the tertiary stage) the iodide of potassium. The following formula will be found satisfactory, in most cases:—

> ℞. Ol. terebinth. f℥jss; Tinct. opii fʒss; Acaciæ, Sacch. alb., āā ʒij; Ol. gaultheriæ gtt. iv; Aquæ f℥iv. M. Sig. Tablespoonful three times a day.

If, however, a very rapid effect be needed, or if the patient cannot take the turpentine, it may be necessary to resort to mercury.

Alopecia is sometimes the source of a good deal of annoyance, and may be treated with washes containing the tincture of cantharides.

The course of treatment briefly sketched in the preceding paragraphs is that adapted to a case of secondary syphilis occurring in a healthy person. If the patient be debilitated, tonics, and especially iron and quinia, should be given at the same time as mercury, if it be deemed safe to give the latter drug at all. The diet should be plain but abundant, and a moderate amount of alcoholic stimulus should be given if the patient is used to its employment. The clothing should be sufficiently warm, and preferably of wool, and great care should be taken to avoid all exposure to wet or cold. The mercurial course should, as a rule, not be begun until the disappearance of the premonitory signs, but should then be continued regularly, and with as few intermissions as possible, until all secondary symptoms have passed by. By careful and judicious treatment, and by strict attention to hygienic rules, there is reason to hope that the disease, if of ordinary mildness, will exhaust its virulence in this stage, and that the patient may thus escape the *tertiary* manifestations of syphilis, which are at the same time the most distressing and the most hopeless. To remove the pigmentary stains left by syphilitic eruptions, Langlebert applies small blisters kept open for a few days, so as to substitute white for copper-colored cicatrices.

Tertiary Stage.—In tertiary syphilis, mercury may be employed (preferably by inunction) for the dry tubercular and squamous eruptions, and for the interstitial form of syphilitic orchitis; but for the other manifestations of the tertiary stage the iodide of potassium is usually a better remedy. It may be given in doses of from five to fifteen grains, three times a day, either alone or in combination with the bitter tonics, mineral acids, or cod-liver oil.

As a *Local Application* to syphilitic ulcers, black-wash, or iodoform, either in powder or in solution with glycerin and alcohol, may be commonly employed; or if the ulceration be widely diffused, as in bad cases of rupia, calomel fumigation may be substituted. For the tertiary affections of the throat, chlorinated gargles, with caustic applications, or atomization of dilute muriatic acid, may be suitably resorted to.

The use of iodide of potassium must often be persisted in, more or less continuously, for many years, and it is therefore a good plan to ascertain by experiment the minimum dose which will keep the symptoms in check, and let that be constantly employed. The same hygienic rules should be observed in the tertiary as in the secondary stage of the disease.

Hereditary Syphilis, in its early manifestations, is best treated by mercurial inunction, in the way already described. In the later stages, iodide of potassium, with tonics, and especially iron and quinia, will be found of service. The saccharated iodide of iron is particularly recommended by Monti. A syphilitic infant need not be weaned if its mother be able to nurse it. It should not, however, be put to the breast of a healthy woman, lest the latter should be infected by contact with secondary lesions in the child's mouth.

If a pregnant woman be syphilitic, she should take mercury, in order, if possible, to prevent abortion, and to save her offspring from inheriting her disease.

Syphilization.—Syphilization, or inoculation with the pus obtained by artificial irritation of a chancre, or with that from a chancroid, was first recommended by Auzias de Turenne, of Paris, both as a prophylactic and as a remedy for syphilis, and has been extensively used in the treatment of the disease by Prof. Boeck, of Christiania. This mode of treatment has been thoroughly tested by a number of surgeons in different parts of the world, and the opinion of the profession is almost unanimously opposed to its employment. Its use as a means of prophylaxis is clearly unjustifiable, for there is no evidence that the artificially inoculated disease is more tractable than that which is acquired in the ordinary way; and as to the curative effect of syphilization, the testimony of most unprejudiced observers tends to show that (1) it is very doubtful whether it exercises any beneficial influence, and that (2) if it do any good, it is probably merely as a means of producing a depurative effect, just as has been done by vaccination, or by the use of blisters.

Inoculation with *chancroidal* pus (which is sometimes practised under the impression that the chancroid is a syphilitic lesion) is quite unjustifiable, as merely adding another disease to that from which the patient is already suffering. I do not recommend a resort to syphilization under any circumstances, and have mentioned it simply as a matter of historical interest.

CHAPTER XXVI.

TUMORS.

THE word *tumor*, in its etymological sense, signifies a *swelling*. In the writings of surgeons and pathologists, however, it is used with a more restricted meaning, and may be defined as a circumscribed enlargement of a part, due to the presence of a morbid growth. Tumors occur in both sexes, and at every age, and may be occasionally found in almost every region of the body. Though originating in and deriving their nourishment from the tissues in which they occur, they have, in a certain sense, an independent organic life, growing or withering without regard to the state of nutrition of the rest of the body. They may be more or less strictly limited by an investing membrane, or may be widely diffused, or infiltrated, among the surrounding tissues. Their anatomical elements may be the same as those of the tissue in which they grow (*homologous, homomorphous*), as in the case of a fatty tumor growing amid fat, or may be quite different (*heterologous, heteromorphous*), always, however, preserving a certain analogy to normal tissue elements, from which, though in character they may deviate, they never entirely depart. Tumors may be either *solitary* or *multiple;* if the latter, they may be of the same or of different kinds. When two or more tumors of the same nature coexist, they may have been developed simultaneously or consecutively; and in the latter case it is occasionally, though (except in the case of cancer) rarely, possible to trace a direct anatomical connection, through the vascular system (as in the process of embolism[1]), or otherwise, between the first, which is then called *primary,* and the *secondary* tumors, or those which are subsequently formed. The origin of *secondary cancerous tumors* is, in the large majority of cases, traceable to absorption from the primary tumor, through the medium of the lymphatic system.

Causes.—The causes of the development of tumors are sometimes sufficiently obvious; as where a cystic tumor results from obstruction of an excretory duct, or where the occurrence of a fatty tumor, or of an adventitious bursa, is directly traceable to the effect of pressure. In most instances, however, no direct cause of the occurrence of a tumor can be detected, while the indirect or predisposing causes are usually matters of conjecture, rather than of demonstration. *Inheritance* is sometimes a cause of the development of tumors, especially of the cancerous variety. *Age,* and the degree of *functional activity* of any particular organ, sometimes exercise a causative influence upon the development of tumors: thus morbid growths are more frequent in adults than in children, and occur more often in an organ the functional activity of which is decreasing, than in one which is undergoing development, or in one which, though completed, is still active. *Sex* exerts a certain causative influence, women being, upon the whole, more liable to tumors than men. Finally, as direct irritation has been seen to give rise to a tumor, it is occasionally possible to trace the origin of a morbid growth to *indirect* irritation transmitted through the nervous system; mammary tumors thus sometimes appear to be caused by uterine disturbance.

Classification of Tumors.—It is a matter of common observation that certain tumors occasion inconvenience merely by their bulk or position, and by their interference with the functions of adjacent parts, having no tendency in themselves to cause death: while other tumors inevitably prove fatal if left to themselves, and have an almost invariable tendency to recur in the same or another part if removed: hence the ordinary division of tumors into those which are *benign, innocent,* or *non-malignant,* and those which are *malignant.* Certain tumors, again, are fatal if neglected, but if removed are not certain, though apt, to recur: these have been looked upon as occupying an intermediate position, and have been called *semi-malignant.* This general division, founded upon the clinical characters of morbid growths, has many advantages, but is obviously not as accurate or scientific as would be a classification of tumors founded strictly upon their anatomical peculiarities. Such a classification has been proposed by Virchow and other authors, and would doubtless have been generally adopted by surgical writers as well as by pathologists, but for the fact that a knowledge of the microscopical characters of a tumor does not always give definite information as to its clinical history, which is of course (from the surgeon's point of view) the most important matter for consideration. The classification adopted in the following pages, aims to combine, in a manner convenient to the student, a reference to both the clinical histories and the anatomical peculiarities of the various morbid growths.

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[1] A remarkable case has, however, been recorded by Hayem and Graux, in which a fibro-plastic tumor of the ligamentum patellæ was followed by a similar growth in the lung, directly traceable to embolism. Other examples of transference of non-cancerous tumors have been recorded by Virchow, Moore, Bryant, and Heitzmann, of New York.

CLASSIFICATION OF TUMORS.

Non-Malignant Tumors.

1. Cystic Tumors; Cysts.

A. Simple, or Barren.

(1.) Serous; hygromata.
(2.) Synovial.
(3.) Mucous.
(4.) Sanguineous.
(5.) Oily.
(6.) Colloid.
(7.) Seminal.

B. Compound, or Proliferous.

(8.) Complex.
(9.) With intra-cystic growths.
(10.) Cutaneous.
(11.) Dentigerous.

2. Solid Tumors and Outgrowths.

(1.) Fatty or adipose.
(2.) Fibro-cellular or connective-tissue.
(3.) Mucous or myxomatous.
(4.) Fibrous, fibro-muscular, fibro-cystic, etc.
(5.) Cartilaginous, fibro-cartilaginous, and mixed.
(6.) Osseous.
(7.) Glandular.
(8.) Lymphoid.
(9.) Vascular.
(10.) Papillary.
(11.) Neuralgic.
(12.) Pulsating.
(13.) Floating.
(14.) Phantom.

Semi-Malignant or Recurrent Tumors.

(1.) Recurrent fibroid.
(2.) Myeloid.
(3.) Sarcomata.

Malignant Tumors.

1. Carcinoma. (Cancer.)

(1.) Scirrhous or hard cancer (Scirrhus).
(2.) Medullary or soft cancer (Encephaloid).
  (*a*) Melanoid.
  (*b*) Hæmatoid.
  (*c*) Osteoid.
  (*d*) Villous.
  (*e*) Colloid.
  (*f*) Fibrous.

2. Epithelioma. (Epithelial or skin-cancer.)

Non-Malignant Tumors, as a rule, displace, without involving, surrounding tissues; they possess considerable vitality, and hence may persist for a long period without undergoing either ulceration or interstitial degeneration; they are homogeneous, or at least do not commonly exhibit, in the same mass, any great diversity of structural elements; and if removed, they do not usually recur.

Malignant Tumors, on the other hand, are commonly infiltrated among the surrounding tissues, which they gradually replace or appropriate to themselves; they possess comparatively little vitality, and hence tend to ulceration and destructive degeneration; they exhibit, in the same mass, a considerable number of diverse structural elements; and though removed with the greatest care, almost invariably recur.

The *Semi-Malignant* or *Recurrent Tumors* occupy an intermediate position; they often grow rapidly and cause ulceration of the over-lying integument; they frequently contain, in the same tumor, a great variety of structural elements; and, though they do not commonly spread to distant organs, they mostly have a strong tendency to recur after even apparently complete removal.

These remarks, though generally, are not universally, applicable. It occasionally happens that a tumor, which is undoubtedly cancerous, does not recur after removal, while, on the other hand, a growth which, structurally, is such as would be placed among the non-malignant tumors, may recur indefinitely, and eventually cause death.

The special characters and appropriate treatment of each variety of tumor which comes under the observation of the surgeon, will now be briefly described.

CYSTIC TUMORS, OR CYSTS.

Cysts may originate in several ways. The most common is from the distention and enlargement of ducts, or sacs, as is usually the case with the mucous and ordinary cutaneous cysts (Retention cysts). Another mode of origin is from the enlargement and coalition of the natural interspaces of the areolar and other tissues; these interspaces being distended with fluid, the surrounding structures undergo condensation, until a cyst wall is formed. It is in this way that adventitious bursæ are formed, as well as cystic developments in solid tumors. A third mode of origin is from the direct growth of newly-formed elementary structures, cells, or nuclei—the cysts thus formed being sometimes called *primary* or *autogenous*, as distinguished from the other, or *secondary*, cysts. Finally, a cyst may be formed by the protrusion and subsequent separation of a portion of a serous membrane, as happens in some cases of so-called "false spina bifida," and probably, as pointed out by Michel, of Charleston, in certain examples of serous cyst of the inguino-femoral region.

A. SIMPLE OR BARREN CYSTS.

Serous Cysts, or Hygromata, may occur in any part of the body, but are most usual in or near glandular structures. These cysts contain a liquid of variable consistency, and of a yellowish, reddish-brown, or olive hue; this liquid sometimes contains crystals of cholestearine, and in other cases is fibrinous and coagulates when removed. The cyst walls are of connective tissue, adherent to surrounding structures, not very vascular, and lined with a tessellated epithelium. These cysts may be single or multiple, and, in the latter case, may intercommunicate, or may be merely aggregated. When found in external parts, they may commonly be diagnosticated by observing that they have a smooth and rounded outline, are movable with, though adherent to, the neighboring healthy structures, are painless, covered with normal skin, and sometimes translucent,[1] and fluctuate, or, if very tense, are at least found to be elastic and resilient on pressure. The *treatment* may consist in puncture (which may also be used as an exploratory measure), the application of tincture of iodine, the injection of the same substance after tapping, the use of a seton, incision with or without cauterization, or partial or complete excision. Iodine injections, or the seton, are particularly adapted for cysts found in the cervical and axillary region, as in the cases described by T. Smith under the name of "congenital cystic hygroma;" and incision, with cauterization or simply stuffing the cavity with lint, for those met with in the gums or bones. Partial incision is usually sufficient if the cyst be solitary, any portion that is left subsequently granulating and undergoing cicatrization. For multiple cysts, however, total excision may be required, and, if seated in the mammary gland, it may be necessary to remove the whole breast, in order to prevent any portion of the diseased structure from remaining. Serous cysts are occasionally connected with vascular nævi, in which case the operation for removal may be attended with profuse bleeding. In the breast, it sometimes happens that a serous cyst coexists with a cancer.

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[1] When occurring in the neck, they constitute the so-called *hydroceles* of that part.

Synovial Cysts may consist simply in enlargement and distention of the normal synovial bursæ; or may be adventitiously developed in abnormal situations, as the result of pressure; or may occur in the sheaths of tendons, constituting *ganglia*. The fluid of these cysts varies in consistency from that of serum to that of honey, and they not unfrequently contain small bodies, about the size and shape of melon-seeds, which may be loose, or attached to the cyst walls, and which are composed of a dense connective-tissue substance. The *treatment* of synovial cysts consists in the use of external irritation, in tapping, followed by stimulating injections, in the formation of a seton, in subcutaneous division and scarification, or, finally, in excision.

Mucous Cysts are chiefly seen in mucous membranes and in connection with the mucous glands, where they result from distention of obstructed ducts or follicles. They are met with in connection with Cowper's or Duverney's glands, in the antrum, and beneath the tongue, where they constitute a form of ranula. Their general characters are those of the serous cysts, from which they differ chiefly in the nature of their contained fluid (which resembles mucus), and in their locality. The *treatment* consists in free incision, or in cutting away a portion of the cyst wall, the cavity being allowed to heal by granulation.

Sanguineous Cysts, or Hæmatomata, may result from accidental hemorrhage into the cavity of a serous cyst (just as hæmatocele from hemorrhage into the sac of a hydrocele), from transformation of a vascular nævus, from occlusion and dilatation of a portion of a vein, or from effusion of blood which subsequently becomes encysted by the condensation of the surrounding areolar tissue. They are chiefly met with in the cervical and parotid regions (in the former locality constituting hæmatocele of the neck), though they also occur in other parts of the body. These cysts contain blood, which may be clotted and partially decolorized, or which may be liquid. In the latter case it may have been fluid from the first, and will then coagulate when evacuated, or may have been clotted at first and subsequently re-liquefied. The walls of these cysts may be simply membranous, or may be deeply ribbed, and the cyst walls may, in some instances, present the characters of a sarcoma or recurrent fibroid tumor. These cysts occasionally resemble, in their outward appearance, encephaloid tumors, with which indeed they may coexist. The *treatment* ordinarily to be recommended for sanguineous cysts, is excision, with precaution against hemorrhage if the cyst be connected with a nævus or bloodvessel; or, if the tumor be very large, it may be reduced in size by repeated tappings, and then laid open, as has been successfully done by Erichsen. Amputation may occasionally be required, as in a remarkable case reported by Moore, in which the cyst was developed in the course of the popliteal nerve, and in which loss of blood during an attempt at excision necessitated the removal of the limb.

Oily Cysts.—Cysts containing oil or fatty matter alone are very rare, though fatty substances not unfrequently occur in cysts, as the result of degeneration of other materials, or as a curdy residue from milk. Oily cysts do, however, occasionally occur in the orbital and superciliary regions, and in the breast. The *treatment* should consist of excision.

Colloid Cysts occur in the kidney and thyroid gland, in the latter situation constituting a variety of goitre. Their contents vary in consistency from that of serum to that of firm jelly, being clear or turbid, and of very variable color. The *treatment* of cystic goitre consists in tapping and the injection of iodine, or the formation of a seton.

Seminal Cysts.—This is the name used by Paget for most examples of the affections usually known as encysted Hydrocele, Hydrocele of the Cord, and Spermatocele. Seminal cysts possibly arise in some cases from dilatation and subsequent isolation of a portion of a seminal tubule, but usually originate in the so-called "non-pedunculated hydatids" which are remnants of the Wolffian body of fœtal life. They may be single or multiple, and may occur in any part of the spermatic cord, though usually just above the epididymis. Their walls are of areolar tissue, sometimes lined with tessellated epithelium, and they contain a milky fluid in which spermatozoa are commonly found. The *treatment* consists in the injection of iodine, or in the use of a seton; or, if these fail, in free incision of the sac, which is then allowed to heal by granulation.

B. Compound or Proliferous Cysts.

These are such as have the power of producing vascular or other organized structures, which may be enclosed within the original cyst wall, or may project from its surface. It is sometimes very difficult to distinguish a true proliferous cyst from a mass of simple cysts closely aggregated together, the latter indeed constituting a considerable proportion of what are known as *multilocular* cysts.

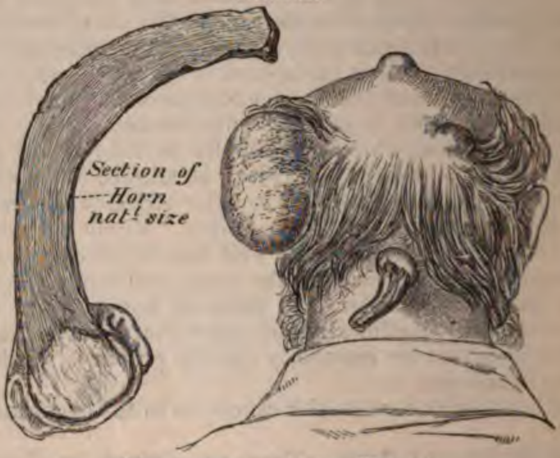
Complex Cystigerous Cysts are chiefly met with in the ovary, and in the chorion, in the disease of that membrane known as the hydatid mole, in which the cysts are probably merely secondary formations (see p. 482). Complex ovarian cysts present a *parent cyst* with numerous secondary cysts variously arranged, which project into its cavity (*endogenous*), or from its surface (*exogenous* growths). Dr. Wilson Fox has carefully investigated the mode of origin of these tumors, and believes that the parent cyst originates, like the simple ovarian cyst, in the Graafian vesicle. Into the interior of the parent cyst, tubular gland structures, or villous or papillary growths (which Dr. Fox looks upon as everted follicles), project, and it is by the dilatation and constriction of these tubules, or by the adherence of these papillary growths, that the secondary cysts are formed. The *treatment* of these ovarian cysts will be considered when we come to speak of ovariotomy. Cystigerous cysts occurring in other parts of the body, could hardly be distinguished from multiple simple cysts aggregated together, and would require the same treatment, viz., total excision.

Proliferous Cysts with Vascular Intra-cystic Growths occur in connection with various glands, especially the mammary and thyroid, though they are also seen in the prostate, in the lip, and in other parts of the body. This class of cysts embraces many of the tumors described by Brodie and others as *sero-cystic sarcomata.* These cysts may be single or multiple, their walls being formed of thin areolar tissue, and closely adherent to surrounding structures. Their contents at first are fluid, but subsequently a vascular growth, apparently of glandular structure, which may be well formed, rudimentary, or degenerate, springs from some point of the interior, and, increasing more rapidly than the cyst, gradually encroaches on its cavity, which it afterwards entirely fills, sometimes at last perforating the cyst wall, and protruding as a fungous mass. The form of these growths varies in different cases; sometimes they appear as layers of coarse granulations, sometimes as nodulated cauliflower-like masses, sometimes as clusters of delicate leaf-like processes, and again as masses of closely-packed lobules. Their color, consistency, and degree of vascularity, are equally various. The course of these tumors is very chronic. The *diagnosis* from cancer may be made by observing the slow progress of the sero-cystic sarcoma, its occurrence at an earlier age (usually from thirty to forty, though it may occur at a much later period), the healthy character of the skin over the tumor, the feeling of fluctuation, if the cyst still contain fluid, and the freedom from disease of the neighboring lymphatic glands. Even when ulceration takes place, and the intra-cystic growth protrudes as a fungous mass, the surrounding integument has not the infiltrated appearance which it has in cases of cancer. Before the skin gives way, it may present a bluish-black color over the most prominent part of the cyst, an appearance which is of itself quite characteristic. The *treatment* consists in total excision, which will usually be followed by a permanent cure, though, if any portion of the growth be allowed to remain, the tumor will be apt to recur; it may even do so after repeated removal, and when every care has been taken in the operation. Virchow records a case in which the tumor traversed the chest wall and involved the lung, and in which metastatic growths existed in the lungs, mediastina, liver, ribs, vertebræ, pelvic bones, dura mater, and sphenoid bone. These tumors have therefore, occasionally, a clinically malignant character, but, as pointed out by Paget, the recurrent are essentially like the primary growths, and never become truly cancerous.

Proliferous cysts may coexist with cancer, as in the ovary and testicle.

Cutaneous Proliferous Cysts.—These are defined by Paget as "cysts within which, in the typical examples, a tissue grows, having more or less the structures and the productive properties of the skin." In the majority of cases, no true cutaneous lining can be recognized, but the cysts are found to contain epidermal scales, sebaceous matter, fat granules, cholestearine, and rudimentary hairs. These cysts are chiefly met with in the ovaries and subcutaneous tissue, but have also been seen in the testicle, lung, kidney, bladder, brain, and tongue. Among those in the subcutaneous tissues, such as are *congenital* approach most nearly to the typical character. These occur usually in the orbital region, close to the external angular process of the frontal bone: they have a round or oval contour, and consist of a thin cyst wall, of a more or less cutaneous structure, pretty tightly filled with oily or sebaceous matter, with or without hair. These cysts are sometimes deeply seated, and may adhere to the periosteum, or even erode, or possibly perforate, the subjacent bone. The *treatment* consists in total excision, which, in the orbital region, requires careful dissection. The common *non-congenital* cutaneous cysts may occur in any region of the body, but are most frequent in the scalp. In this situation they are very loosely attached, so that they may commonly be readily removed by transfixing and laying open the tumor, and, after evacuating the contents, pulling out the cyst wall with forceps. In other parts of the body they may require more careful dissection. These *sebaceous tumors*, as they are ordinarily called, sometimes appear to have very thick walls, owing to the accumulation of epithelial *débris* in their interior. In some cases a dark spot is observed on the surface of the tumor, which marks an orifice through which a probe can be introduced, and through which the contents of the cyst may perhaps be evacuated. In these cases, it is probable that the cyst has originated from obstruction of a sebaceous duct, though in other instances these growths appear to be autogenous formations. Sebaceous tumors may become inflamed, when the cyst, if small, may be loosened and thrown off by suppuration; in other cases, ulceration takes place, and the contents of the cyst protrude, becoming dry by exposure, and constituting some of the so-called "horns" of the face or other parts. Occasionally the protruded contents of a cutaneous cyst become vascular, and present the appearance of a fungous, bleeding mass, which may be mistaken for cancer. The *treatment*, as already observed, consists in total excision, but this should not, as a rule, be done unless the patient be in good general health at the time, as the operation, though in itself a trifling one, has not unfrequently been followed by fatal erysipelas.

FIG. 202.



Sebaceous tumors and horn. (BRYANT.)

Sebaceous cysts in the auditory canal, or in the orbital region, may occasionally prove fatal by perforating the skull, and inducing meningeal and cerebral inflammation. Hence, early excision is particularly imperative in these cases.

Dentigerous Cysts, or cysts containing teeth, occur in the ovaries and testes, but are chiefly interesting to surgeons when met with in the upper or lower jaw. These cysts appear to be tooth capsules, from which the teeth, though well formed, have not been extruded, and which become enlarged by the accumulation of fluid. The *treatment* consists in making a free opening into the cyst, taking away a portion of its wall, and, after extracting the misplaced tooth, stuffing the cavity with lint.

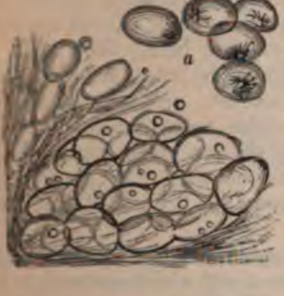
NON-MALIGNANT SOLID TUMORS AND OUTGROWTHS.

The term *Outgrowth* is here used in the sense in which it is employed by Paget to denote the "*Continuous Hypertrophies*" which are occasionally met with, in which the limiting and investing capsule of a *Tumor* or "*Discontinuous Hypertrophy*" is absent. These *outgrowths* differ from the *infiltrations* of malignant diseases in that, in the former, the new material is homologous with that which surrounds it, while in the latter it is quite different, causing indeed degeneration and wasting of the normal tissue in which it is placed.

Fatty Tumors and Outgrowths.—These are the most common of all the non-malignant tumors, and have been described by surgical writers under various names, such as *Lipoma*, *Steatoma*, etc. The *Fatty Outgrowth* consists of an accumulation of fat in the subcutaneous tissue of some part of the body, and may be either single or multiple. It is usually annoying only on account of the deformity produced, but is occasionally painful. A favorite seat of the fatty outgrowth is the neck, where it gives the appearance known as a *double chin*. It also occurs in the abdominal walls, and may be met with in other situations. Brodie succeeded in procuring the absorption and disappearance of a growth of this kind by the internal use of liquor potassæ, but usually excision would be the only means likely to effect a cure, and this could rarely be advisable, for the resulting scar would probably be as disfiguring as the disease itself.

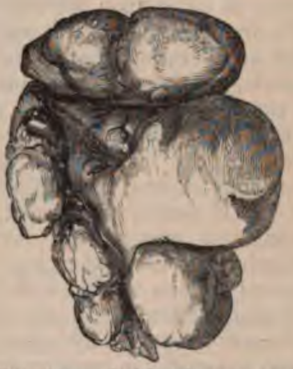
The *Fatty* or *Adipose Tumor*, or *Lipoma Circumscriptum* of systematic writers, is a much more common affection. It usually occurs in the trunk, especially the upper part, or in the proximal portions of the limbs, though it may be met with in any region of the body, as beneath the tongue, in the sole of the foot, or in the scrotum. A peculiarity of the fatty tumor is its proneness to *shift its position*, in obedience to the law of gravity; thus a lipoma has been known to pass from the groin to the perineum, or from the abdominal wall to the thigh. The usual seat of a fatty tumor is in the subcutaneous tissue, though cases are on record in which these growths have been found in the intermuscular planes, in contact with bones or joints, in the nerves, and in the fat around internal organs. Fatty tumors are always invested by capsules, fibro-cellular in structure, and of varying density; from the capsule, septa pass inwards, dividing the tumor into lobes of various size. The capsule is dry, and supplied with bloodvessels, and separates the tumor from the surrounding structures. Its layers have less cohesion among themselves than adhesion either to the tumor or to the neighboring tissues. The skin adheres to the capsule more closely at the points at which the septa pass off than at other parts, thus giving a dimpled appearance to the mass when it is lifted away from the subjacent structures. The fat of an adipose tumor does not differ materially from the ordinary normal fat by which the mass is surrounded, though, according to Butlin, the individual cells of the tumor are much larger than those of adipose tissue in general. The development of fat in a tumor is like that of natural fat, the gradual formation of fat cells from connective tissue corpuscles being, according to Weber, as

FIG. 203.



Structure of a fatty tumor; *a*, isolated cells showing crystalline nucleus of margaric acid. (BENNETT.)

FIG. 204.



Fatty tumor; the lobated appearance well shown. (MILLER.)

quoted by Paget, traceable in these tumors. Fatty tumors derive their vascular supply chiefly from arteries that ramify in the capsule, though, in addition, a large vessel frequently passes directly into the mass.

Fatty tumors are usually single, but may coexist in large numbers, fifty-eight having been observed in one case by R. P. Harris, of this city. They are most common in early adult and in middle life, and, as a rule, grow very slowly. They occasionally attain a very large size, one being referred to by Gross which weighed not less than seventy pounds. Fatty tumors are usually, though not always, painless. They occasionally inflame and ulcerate (particularly such as are pendulous), and may contain oily cysts, or bony or calcareous nodules.

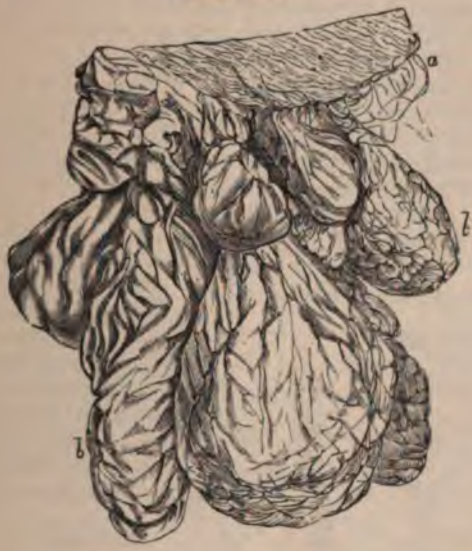
The *diagnosis* can commonly be made by observing the smooth, indolent, lobated character of the swelling, the sensation of elasticity or semi-fluctuation communicated to the touch, and the peculiar dimpling, corresponding with the position of the interlobar septa, when the skin is rendered tense by compressing and lifting the mass. Another point, insisted on by Labbé, is that by thus manipulating the skin the general surface becomes red, while the positions of the interlobar septa are marked by white lines. The surgeon may also avail himself of the knowledge that all fatty matters become hardened by the application of cold, and thus aid the diagnosis by directing a spray of ether upon the surface of the tumor.

The *treatment* consists in excision, which may be practised in any case in which an operation of any kind would be admissible. A single incision may be made, corresponding as much as possible with the long axis of the tumor and the natural curves of the part, and, the capsule being then split with the knife, the whole mass may be often enucleated, by traction aided by the handle of the instrument. Occasionally, however, prolongations of the tumor may extend into deeper parts, and require more careful dissection. The cure is usually permanent, though, if any portion of the tumor be left, reproduction may possibly occur. In the case of pendulous growths, and particularly if ulceration have occurred, it may be proper to remove an elliptical portion of skin with the tumor.

Should excision be in any case contra-indicated, attempts may be made to disperse the tumor by injections of alcohol or ether, which are said to have proved successful in cases recorded by Hasse, of Nordhausen, and Schwalbe, of Weinheim.

Fibro-cellular Tumors and Outgrowths are such as in their anatomical characters resemble the ordinary areolar or connective tissue. The *Outgrowths* are more common than the tumors, and constitute most of the softer and more succulent kinds of *Polypi*, as well as the *Cutaneous Outgrowths*, or *Wens*, which are so frequently met with in the generative organs, and other parts of the body. In the polypi, the fibro-cellular is commonly associated with gland structure, while in the cutaneous outgrowths the skin itself appears to be hypertrophied. Closely connected with these *fibro-cellular outgrowths* are the cases of *Elephantiasis Arabum*, *Scleroderma*, etc., which are chiefly observed in the scrotum and lower extremities, and which are occasionally accompanied with a dilated state of the lymphatics, with or without lymphorrhœa, and more rarely with a nævoid condition of the skin and subjacent tissues. If these wens are of moderate size, they may be readily removed, but if very large, the operation, though justifiable, becomes a rather formidable proceeding. When met with in the form of "Barbadoes leg," attempts may be made to reduce the swelling by the continued use of firm compression by means of the elastic bandage, and, as advised by Olavide, of Madrid, by the internal and external use of iodine; and if these fail, it may occasionally be proper to resort to ligation of the main artery of the limb[1]—an operation which has been performed under these circumstances with good results by Carnochan, Crosby, and numerous other surgeons, but which is, according to Fayrer, usually productive of only temporary benefit. The statistics of this mode of treatment have been particularly studied by Casati, Wernher, Fischer, Leonard, and Leisrink, the latter of whom has collected about 30 cases, from an examination of which he concludes that though the operation frequently fails, yet it is often productive of benefit, and occasionally effects a complete cure. Leonard, of Bristol, refers to 69 cases, of which 40 ended in recovery (3 of these after digital compression of the artery); in 13, relief was afforded; and only 16 were totally unsuccessful.

Fig. 205.



Fibro-cellular tumor of labium. (Holmes.)

Casati has analyzed 24 cases as follows:—

Ligation of	Cases.	Recovered.	Relieved.	Disease returned; no benefit.	Died.
Iliac artery, ...	5	. .	. .	2	3
Femoral artery, ...	12	5	4	1	2
Popliteal artery, ...	1	1	. .	. .	. .
Spermatic artery, ...	2	2	. .	. .	. .
Axillary artery, ...	1	. .	. .	. .	1
Brachial artery, ...	3	2	1	. .	. .
Total, ...	24	10	5	3	6

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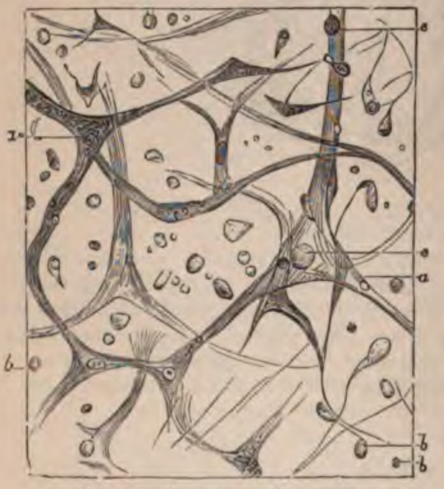
[1] The *sciatic nerve* was resected in a case of elephantiasis by Dr. Morton, of this city, with the effect of considerably reducing the size of the limb, but the case terminated fatally five months after the operation.

Fibro-cellular *Tumors* are comparatively rare affections. They are chiefly met with in the deep intermuscular planes of the limbs, the scrotum, labium, and vaginal wall, but are occasionally seen in the subcutaneous tissue, or in other parts, as the testicle, tongue, or orbit. These tumors occur as firm, round, or oval masses, tense, somewhat elastic, and invested with a thin capsule of areolar tissue. In this respect they markedly differ from the cutaneous *outgrowths* met with in the same regions, for these are continuous with the surrounding structures. On laying open a fibro-cellular tumor, it is found to consist of opaque white, intersecting bands of contractile tissue, the interspaces being filled with a more or less viscid serous fluid, of a yellowish-green or yellow hue. This fluid flows or may be squeezed out, the filamentous structure then contracting, and assuming a firmer and denser appearance. The tumor, in fact, closely resembles a mass of œdematous areolar tissue. Under the microscope, the elements of ordinary connective tissue are seen—undulating filaments, with nuclei (rendered more distinct by acetic acid), and elongated cells of various forms. Yellow elastic tissue is very rarely found, but cartilaginous or bony nodules are occasionally observed.

These tumors are met with in late adult life, and increase in size rather rapidly, more, however, by serous distension than by absolute growth. They are usually painless, giving trouble only by their position and weight, which sometimes exceeds forty pounds. When very large and dependent, they may cause ulceration or sloughing of the surrounding skin. The *treatment* consists in excision, the growth being enucleated as a fatty tumor from its capsule. The operation usually results in a permanent cure.

FIG. 206.



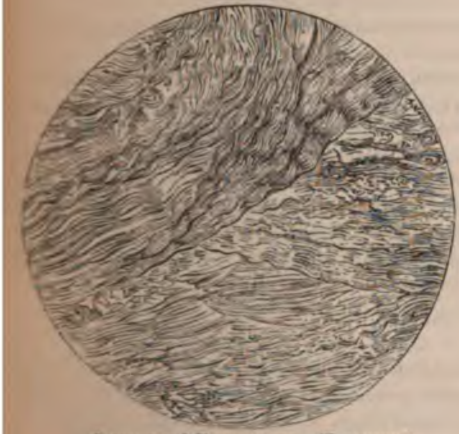
Structure of myxoma. (HOLMES.)

Myxoma, or Mucous Tumor, is a name given by Virchow to a rudimentary form of fibro-cellular tumor, which on section has a quivering, jelly-like appearance, the contained yellow fluid readily flowing away, and the microscopic appearances of the tumor presenting oval, elongated, or branched corpuscles, with indistinct fibrillæ, and imperfectly formed filaments. The structure of the tumor resembles, in fact, embryonic connective tissue, or the so-called *mucous* tissue of the umbilical cord. *Myxomata* occur in the connective tissue of the brain, eye, nasal septum, breast, nerves, neck, or extremities, and in suitable cases may be excised with a prospect of permanent relief. When met with in the eye, they require extirpation of the globe. The disease of the chorion known as the *hydatid mole*, is believed by Virchow to be an example of myxoma, consisting in hypertrophy of the proper tissue of the villi of the membrane in question. The cysts which are met with in this disease are, according to Paget, probably not essential, but merely secondary formations (see page 476.)

Fibrous Tumors and Outgrowths (including *Fibro-muscular*, *Fibro-cystic*, and *Fibro-calcareous Tumors*).—Fibrous or *fibroid* tumors and outgrowths (also called *desmoid*, *chondroid*, and *tendinous*) are such as anatomically resemble the ordinary fibrous or ligamentous tissue. Under the head of fibrous outgrowths, may be included most of the firmer polypi met with in the uterus, nose, pharynx, etc.

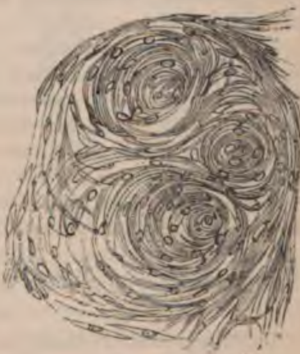
Fibrous tumors have naturally a round or oval shape, and are smooth, or but slightly lobed on the surface. Under the influence, however, of gravity or pressure, they deviate from the normal form, becoming pyriform when pendulous, and when confined in a cavity, becoming gradually moulded to its shape. Fibrous tumors are usually surrounded with a capsule of connective tissue, and when cut into present a basis-substance, commonly of a yellowish or bluish-gray color, intersected with very numerous opaque white bands. These white fibres are variously arranged, sometimes in concentric circles, sometimes in undulating bundles which interlace with each other, and sometimes again matted closely together, so as to appear to the naked eye as a nearly uniform, white, glistening mass. The tumors are more or less lobed, and divided by septa of areolar tissue, the vascularity of the growth being greatest in those tumors which are most loosely arranged. Beside the characteristic fibres seen in sections of these tumors, there are commonly fusiform cells and nuclei perceptible; and elastic fibres, plates or spiculæ of bone, and cartilage, may occasionally be found mingled with the fibrous tissue. In the uterus, and occasionally in other situations, the fibrous tissue may be so mixed with non-striated muscular fibre as to entitle the tumor to be called *Fibro-muscular;* if the muscular fibre be in excess, the tumor becomes a *Myoma* (Virchow), the *Muscular Tumor* of Vogel. The *Fibro-cystic* and *Fibro-calcareous* varieties are the result of secondary degeneration, and may occur in either the ordinary fibrous or in the fibro-muscular tumor. In the *fibro-cystic* tumor the cyst may be single, but more frequently there are a number of cysts, variously scattered through the mass; this is well seen in the disease of the testicle to which Cooper gave the name of "hydatid testis." The occurrence of *calcareous degeneration* in fibrous tumors is chiefly seen in those met with in the uterus, and indicates a cessation of growth in the morbid mass. *Fatty degeneration* occasionally, though rarely, occurs in fibrous tumors.

FIG. 207.



Structure of fibrous tumor. (ERICHSEN.)

FIG. 208.



Structure of fibro-muscular tumor of the uterus. (BENNETT.)

The favorite seats of fibrous tumors are the uterus, the nerves (where they constitute the disease called *neuroma*),[1] the bones and periosteum (especially about the jaws), the subcutaneous areolar tissue, that in the neighborhood of joints, the tendinous sheaths, the testes, and the lobules of the ear, when pierced in order to wear ear-rings; they are also met with, though more rarely, in the breast, prostate, submucous and subperitoneal areolar tissues, and possibly in other localities.

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[1] Or the *false neuroma*. (See Chap. xxviii.)

Fibrous tumors are usually solitary, except in the uterus and nerves, where they are commonly multiple, and may exist in large numbers. They are of slow growth, are indolent, and attain sometimes a very large size—weighing perhaps over seventy pounds; they may persist for thirty years, or even longer. Sometimes they become œdematous, and soften internally, the outer part giving way or sloughing, and the disintegrated interior being discharged; an irregular cavity is left, from which fungous and bleeding granulations may protrude, giving the part a decidedly cancerous appearance.

The *diagnosis* of fibrous tumors may usually be made by observing their smooth and regular outline (unless distorted by compression), their uniform firmness, their mobility (when in the subcutaneous tissue), their slow growth and painlessness, and the healthy character of the surrounding tissues. When growing in, or connected with, bones, the diagnosis from other forms of tumor is often very difficult, and sometimes almost impossible, until after removal of the growth.

The *treatment* consists in excision, in situations admitting of this operation, the tumor being enucleated from its capsule, if this can be done, and if not, removed by careful dissection. When the tumor springs from bone, as in cases of epulis, it is necessary to remove, with the growth, the osseous surface to which it is attached. Recurrence is rare, except in the case of the tumors met with in the ear, where the growth presents some analogies to the *keloid* seen in cicatrices. Occasionally, however, fibroid tumors occur which are truly malignant, and which resemble cancerous growths in every point except their structure; these have indeed been called *Fibrous Cancers*, but *Malignant Fibroid Tumor* would seem to be a better name.

Cartilaginous Tumors, or Enchondromata (including *Fibro-cartilaginous* and *Mixed Tumors*).[1]—The anatomical and chemical characters of these growths are essentially those of fœtal cartilage. Enchondromata are commonly lobulated, and (in parts unconnected with bone) invested with a dense connective-tissue capsule, from which proceed septa which divide the lobules from each other. On section, these tumors present a glistening, bluish, or pinkish-white appearance, and differ from other non-malignant growths in that they show, under the microscope, a considerable diversity of structure in specimens derived from the same tumor. The intercellular substance has a more or less fibrous appearance, and is often so markedly fibrous as to render the name *Fibro-cartilaginous* appropriate. The cells vary greatly in number, size, shape, and mode of arrangement, and are sometimes so fused with the basis-substance that the nuclei alone are perceptible. The nuclei themselves vary in different specimens, occasionally seeming shrivelled, or containing oil globules, or having a granular appearance.

Cartilaginous tumors are commonly hard and resisting, though sometimes soft and compressible; they are always elastic. They interfere but little with surrounding structures, which remain healthy, though displaced by the growing mass; if the part be exposed to friction, a bursa sometimes forms over the prominent part of the tumor. Enchondromata usually occur at an early period of life.

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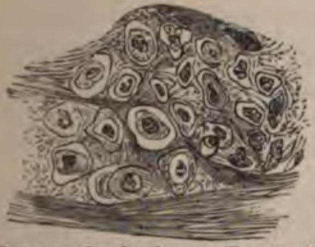
[1] The "*loose cartilages*" met with in joints present certain analogies to enchondromata, but will be more conveniently considered in another part of the volume.

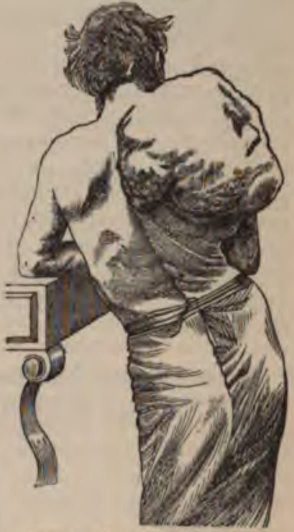
These tumors are most frequently seen in connection with *bones* (when they may grow beneath the periosteum, or in the medullary cavity), but also occur in or near the *parotid gland*, in the *testis* or *mamma*, and occasionally in other localities. Their rate of increase, and the size to which they may attain, are both extremely variable; Paget mentions a cartilaginous tumor which, after four years, was but half an inch long; and another which, in three months, occupied nearly the whole length of the thigh, and was as large round as a man's chest.

FIG. 209.



Structure of enchondroma. (ERICHSEN.)

FIG. 210.

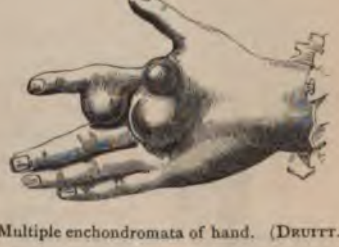


Large enchondroma of scapula.

The principal changes which occur in enchondromata, are ossification and degenerative liquefaction. Ossification may take place in the older portion of a tumor, while the rest is still growing, or may occur in the form of detached bony nodules scattered through the mass. As a result of degeneration, or possibly of arrested development, a honey-like or jelly-like fluid is often found in one or more parts of an enchondroma, giving a soft and fluctuating character to the tumor. As the result of inflammation and ulceration, an enchondroma may protrude and slough, leaving a large suppurating and offensive cavity, and death may occur from exhaustion under these circumstances.

A large proportion of the so-called *Mixed Tumors* contain cartilage as one element of their structure. Thus, nodules of cartilage may occur in fibro-cellular tumors, and, on the other hand, enchondromata may contain cysts, glandular tissue, or myeloid structure — and may even be apparently mingled with encephaloid, in the same general mass.

FIG. 211.



Multiple enchondromata of hand. (DRUITT.)

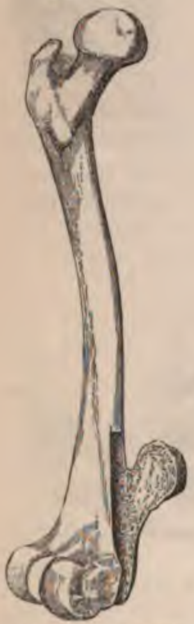
Cartilaginous tumors are usually solitary, except when occurring in the bones of the hands, where they are commonly multiple. The bones most frequently affected, after those of the hand, are the femur and tibia, and, next to these, the humerus, ribs, pelvis, and last phalanx of the great toe— though enchondromata have been occasionally seen in almost every bone of the body. When growing near the articular extremity of a long bone, a cartilaginous tumor is usually seated between the periosteum and bone, gradually eroding the wall of the latter, and involving it in its own mass. The articular extremity itself is probably never involved. Enchondromata in the middle of the shaft of a long bone are rare, and, when met with, commonly grow both externally and internally, the bone wall finally yielding, and the tumors coalescing. In the hand, enchondromata arise within the bone, the walls of which they gradually expand; but in the rare cases of single enchondromata in this situation, the tumors are subperiosteal, as in the long bones.

The *diagnosis* may usually be made by observing the various characters which have been described as belonging to the enchondroma, especially its hardness combined with elasticity; but when occurring in certain situations, as within the jaw, the diagnosis from other innocent tumors may be impossible until after excision.

The *treatment* of cartilaginous tumors consists in removal of the growth by enucleation, dissection, excision, or amputation, according to the locality and other circumstances of each particular case. Enchondromata rarely recur after removal, though they may do so when of a soft and rudimentary structure: when mixed with cancer, the latter affection runs its course independently. A case has been recorded by Moore, in which a pure enchondroma gave rise to secondary deposits in the lungs by a process analogous to embolism.

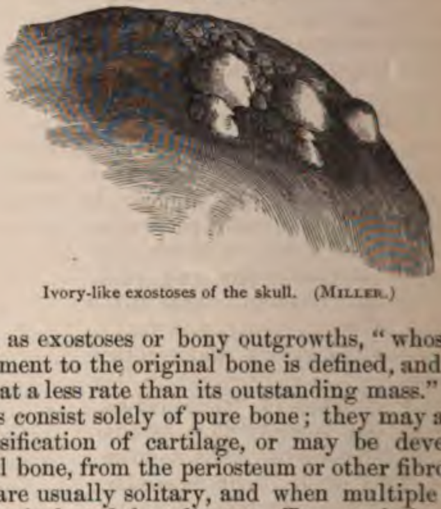
Osseous Tumors and Outgrowths; Exostosis.—*Osseous Tumors* are very rare except in connection with bone, and may be defined, in the words of Paget, as exostoses or bony outgrowths, "whose base of attachment to the original bone is defined, and grows, if at all, at a less rate than its outstanding mass." Osseous tumors consist solely of pure bone; they may arise from the ossification of cartilage, or may be developed, as normal bone, from the periosteum or other fibrous tissue. They are usually solitary, and when multiple are often symmetrical and hereditary. Two varieties of bony tumor may be recognized, the *cancellous* (consisting of a thin layer of compact substance, with cancellated structure and marrow internally), and the *compact, hard,* or *ivory-like, bony tumors,* which consist, as their name implies, of hard and solid bone.

FIG. 212.



Cancellous exostosis, growing from the lower part of the femur. (DRUITT.)

FIG. 213.



Ivory-like exostoses of the skull. (MILLER.)

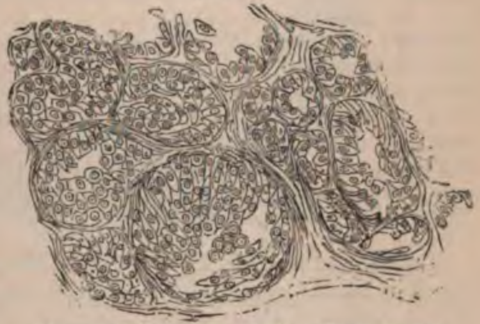
The *cancellous* tumors usually constitute the ultimate stage of the cartilaginous tumors already described; they are indolent, and when thoroughly ossified rarely grow; they are situated outside of the bones with which they are connected, and in suitable cases may be treated by excision. A favorite locality of this form of bony tumor is the last phalanx of the great toe, where it grows from the inner margin of the bone, lifting up the nail and causing troublesome ulceration of the skin; it is very seldom that any but the great toe is affected. The treatment consists in excision, taking care to remove, with the growth, the bony surface from which it springs. Birkett has recorded a remarkable case of cancellous exostosis of the frontal bone.

The *ivory-like* bony tumors are rare, except in connection with the cranial bones (Fig. 213), where they may be small, superficial, and perhaps pedunculated, or may originate in the diploë or frontal sinus,[1] etc., where they may grow both inwardly and outwardly, in the form of large nodulated masses, involving the orbit, causing protrusion of the eyes and great deformity, and perhaps inducing fatal compression of the brain. For the superficial variety, excision may occasionally be attempted, though the operation is sometimes rendered impossible by the hardness of the tumor. For the deep orbital growths, attempts at excision are not to be recommended, but as a cure has sometimes followed necrosis and spontaneous separation of the mass, it may be proper to expose the most prominent part of the tumor, and apply nitric acid or caustic potassa, as recommended by Stanley, in hope of inducing exfoliation.

Those exostoses which are not pedunculated, and which, therefore, are properly called *Outgrowths* (*Osteomata*), in contradistinction to osseous *tumors*, do not, as a rule, admit of removal. A favorite seat of these growths is in the superior maxillary bones, whence they may spread to other bones of the face, causing great deformity, or even death, by interference with the brain. If limited to the jaw, and to one side, excision of the bone might be properly tried; but if bilateral, or involving neighboring parts, no operation should be attempted, except, perhaps, the application of caustics, as in the frontal and orbital growths already referred to.

Glandular Tumors.—These, which are also called **Adenomata**, or **Adenoid Tumors**, are such as in their structure resemble the normal glands, whether the secreting, lymphatic, or ductless glands. The principal localities of adenoid tumors are in or near the mammary, the prostate, the thyroid, the labial, and the lymphatic glands, though they also occur in the parotid, sebaceous, and sudoriferous glands. Glandular structure, moreover, forms an important part of the submucous fibro-cellular tumors which constitute mucous polypi, as well as of the complex ovarian cysts. The mammary and probably some other glandular tumors, sometimes appear to originate as proliferous cysts, which become solid by the extension of intra-cystic growths.

Fig. 214.



Adenoma of the mamma. × 300. (Rindfleisch.)

Glandular tumors have usually a regularly curved outline, are somewhat lobated, and may be flattened by pressure. They have commonly a distinct investing capsule of connective tissue, and are but slightly vascular. On section, they appear of a gray or yellowish-white hue, of variable density and elasticity, and are frequently intermingled with cysts. The labial and parotid adenomata may also contain nodules of cartilage or bone. Their growth is extremely variable, and, though usually indolent, glandular tumors, especially of the breast, are occasionally the seat of great pain. They occasionally disappear by absorption: thus a mammary adenoma may be entirely removed without operation, upon the restoration of the suspended functions of the mammary gland itself, or of the uterus.

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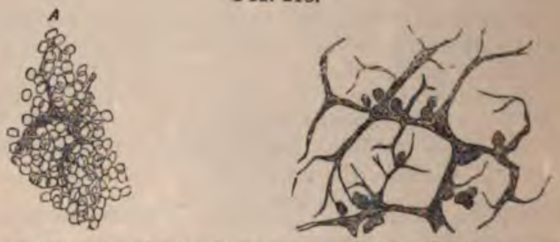
[1] According to Dolbeau and others, many of these ivory-like tumors originate in the mucous membrane of the nasal fossæ and other cavities of the face; their attachments to surrounding parts are then very slight, and their enucleation comparatively easy. (See a Critical Review by Rendu, in the *Archives Générales de Médicine* for August, 1870.) Colignon reports a case in which such a growth was successfully removed by Demarquay from the maxillary sinus. (*Gaz. Méd. de Paris*, Fév. 21, 1874.)

The *treatment* consists in the use of pressure, with the application of sorbefacients, and, when these fail, in excision, which can usually be readily effected by enucleation. The interstitial injection of alcohol is recommended by Schwalbe, of Weinheim.

Lymphoid Tumors.—This name is used by Prof. Turner as equivalent to the *Lymphoma* of Virchow, "to express those new formations which, in their essential structure, are composed of corpuscles like the round, pale corpuscles that form the characteristic cell-elements of the lymphatic glands."

FIG. 215.



Lymphoma.—A, a thin section of a lymphomatous tumor of the mediastinum. B, a similar section, from which most of the cells have been removed by pencilling, so as to show the reticulated network, and the nuclei in its angles. This network is much more marked than that often met with. × 200. (Green.)

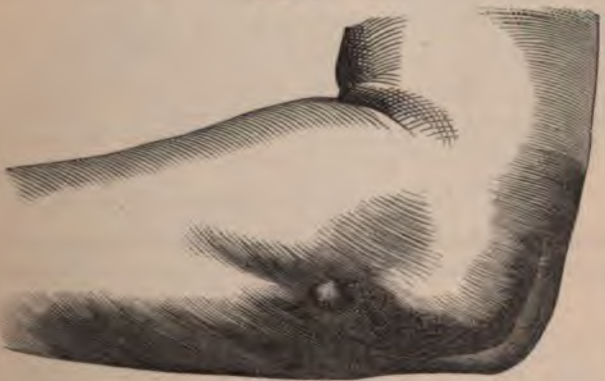
In many cases these lymphoid tumors occur in parts where lymphatic glands are known to exist, but in other instances they have been met with as entirely independent formations. They are frequently multiple. They have been observed by Virchow in the liver and kidney, by Church in the mesentery and extra-peritoneal tissue, and by Murchison in all these organs, as well as in the intestine and heart, The *treatment* recommended by Billroth and Czerny is the use of arsenic both internally and by parenchymatous injection; excision is occasionally justifiable.

Vascular or Erectile Tumors (Angeiomata) are of most frequent occurrence in the skin and subcutaneous tissue, though they may also be found in any structure which is itself vascular. They are subdivided, according to their structure, into the capillary, arterial, and venous vascular tumors. The arterial variety constitutes the disease known as *Aneurism by Anastomosis*, while the capillary and venous vascular tumors are what are commonly designated as *Nævi*. The diagnosis and treatment of these affections will be considered in the chapter on diseases of the Vascular System. *Lymphatic Vascular Tumors*, erectile, and usually congenital, have been occasionally described. They closely resemble some of the venous vascular tumors, but contain a fluid resembling lymph, instead of blood.

Papillary Tumors (Papillomata) resemble in structure the ordinary papillæ of the cutaneous and mucous tissues. They occur in the *skin* where they form the common cutaneous warts, and some of the so-called horns, met with chiefly about the face and head; and in the *mucous membranes*, where the papillary structures may occur in connection with fibro-cellular growths, in the form of mucous polypi, may be scattered over a considerable extent of surface, giving the part a villous appearance, or may be aggregated into distinct tumors: the mucous membranes chiefly affected are those of the larynx, colon, rectum, bladder and urethra. I have seen a well-marked papilloma of the tongue in a boy, the affection being attributed to the patient's habit of smoking stumps of segars which he picked up in the street. According to R. W. Taylor, the warty form of lingual ichthyosis is a true papilloma. Finally, papillary growths may occur in *serous tissues*, particularly the arachnoid; the Pacchionian bodies are, according to Von Luschka, merely enlargements of the villi normally existing in this part. The papillary tumors, above referred to, are of a non-malignant character, and must not be confounded with *Villous Cancer* (see p. 502). The *treatment* of papillomata consists in excision, ligation, or the application of caustics, according to the size and situation of the growth.

Neuralgic Tumors.—This is a group embracing such tumors as are, without any perceptible reason, the seat of intense neuralgic pain. They are usually fibrous or fibro-cellular in structure, though adipose, fibro-cartilaginous, or even glandular tumors may occasionally be similarly affected. The *Painful Subcutaneous Tumor* or *Tubercle*, which is the most common of the neuralgic tumors, is usually seen on the limbs, particularly the lower, but occasionally on the face or trunk. It is rarely more than half an inch in diameter, has a round shape, and is firm, tense, and elastic. It is usually single, and is much more common in women than in men—in both respects differing from the ordinary neuroma, which is frequently multiple, and is oftenest seen in the male sex. The painful subcutaneous tubercle is an affection of adult life.

FIG. 216.



Painful subcutaneous tubercle on the forearm. (SMITH.)

In many instances, the most careful dissection has failed to show any connection between these tumors and nerve fibres, though it is believed by many writers that the painful subcutaneous tubercle is really a "true neuroma" (see Chap. XXVIII.), containing an excessive formation of nervous elements.[1]

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[1] See Labbé and Legros, in *Journal de l'Anatomie, de la Physiologie*, etc., t. vii. (1870), p. 171.

The so-called "irritable tumor of the breast" is properly termed a neuralgic tumor, being, indeed, often really a painful subcutaneous tubercle, though occasionally a simple adenoma.

The pain in all of these cases is of a paroxysmal character, and is often compared to an electric shock. During the paroxysm, the tumor itself commonly becomes sensitive and swollen.

The *treatment* consists in excision, which operation may be expected to afford permanent relief. As a palliative measure, circumferential pressure, with a ring placed around the tumor, may be occasionally resorted to with advantage.

Pulsating Tumors.—These are such as have a pulsation, due to the state of the bloodvessels in the tumor itself, independently of its proximity to a large vessel. The pulsating tumors are the *arterial vascular* (aneurism by anastomosis), the *myeloid*, and the *encephaloid*—the two latter pulsating only when the tumors are partially surrounded by bone. The chief interest pertaining to pulsating tumors is the liability of mistaking them for aneurisms, an error which has occasionally been committed by the most distinguished surgeons.

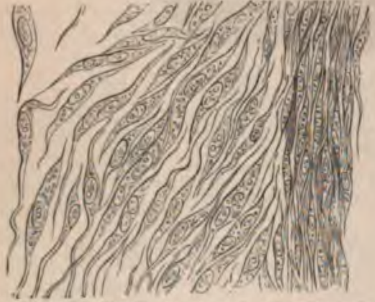
Floating Tumors are tumors felt in the abdomen, which change their place and float away, as it were, under the surgeon's manipulations. They consist in some cases of movable kidneys, but are probably sometimes loosely-attached ovarian cysts, portions of thickened omentum, etc., or even fecal accumulations.

Phantom Tumor is the name given to an apparent tumor which vanishes spontaneously, and which usually consists of a partially and spasmodically contracted muscle. In other cases an accumulation of gas, or a thickened or fatty omentum, has been known to simulate an ovarian tumor, and laparotomy has actually been performed under these circumstances. The usual seat of phantom tumors is in the abdomen, though they are occasionally seen in other localities.

SEMI-MALIGNANT OR RECURRENT TUMORS.

Recurrent Fibroid Tumors.—It has been remarked, in describing almost each form of non-malignant tumor, that under certain circumstances it may recur after removal, and occasionally with such persistence as to make the tumor clinically malignant. There is one common characteristic of all these *recurrent tumors*, and that is the rudimentary or embryonic state of their component tissues: thus the majority (which belong to the fibro-cellular and fibrous varieties of tumor, and are hence called by Paget the *Recurrent Fibroid*) contain a large number of elongated, caudate, or spindle-shaped cells, like the granulation or *fibro-plastic* cells, and correspond to what Virchow calls the "*Spindle-celled Sarcoma.*"

FIG. 217.



Recurrent fibroid tumor, or spindle-celled sarcoma. (GREEN.)

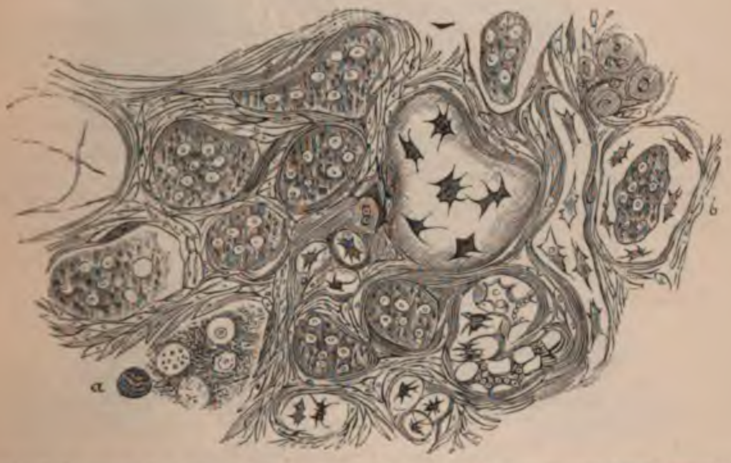
These *recurrent tumors* differ in general character from the non-recurrent growths of the same varieties, in being softer and more friable, rather more juicy, and somewhat more glistening on section. Under the microscope they exhibit a large proportion of cells, and fewer formed fibres, with large and often free nuclei and nucleoli.

Under the name of *Fibro-nucleated Tumor*, is described by Bennett a group of recurrent tumors very analogous to the *recurrent fibroid* of Paget, and which, under the microscope, exhibits filaments, with elongated, oval, nucleolated nuclei.

The *treatment of recurrent tumors* consists in excision, which may be repeated as often as the tumor reappears. A permanent cure is occasionally obtained after repeated removals, though more often the patient ultimately dies from exhaustion caused by the ulceration of the tumor, which commonly returns with a shorter interval after each operation. Esmarch is said to have prevented the redevelopment of recurrent tumors by the administration of large doses of iodide of potassium.

Myeloid Tumors are such as in their microscopic characters resemble fœtal marrow. The characteristic myeloid cells are round, or irregularly oval, clear, or slightly granular, from $\frac{1}{1000}$ to $\frac{1}{300}$ of an inch in diameter, and containing from two to ten, or even more, nucleolated nuclei. Beside these, there may be free nuclei, and lance-shaped, caudate, or spindle-shaped (*fibro-plastic*) cells, whence the name sometimes used of *Fibro-plastic Tumor*, though this is more appropriate to the *recurrent fibroid* variety.

FIG. 218.



"Giant-celled sarcoma," or myeloid tumor. *a* points to a part where cysts were being formed by the softening of the tissue of the tumor; *b*, to a focus of ossification. (BILLROTH.)

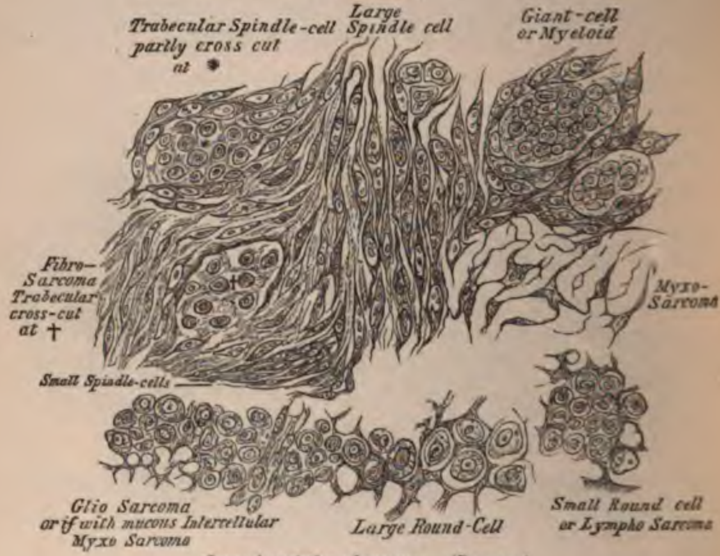
These tumors are rarely found except in the bones, where they usually occur as internal growths. When not so situated, they have commonly a firm, fleshy feel, but are occasionally soft and easily broken. On section, they have a yellow or gray, glistening appearance, marked with spots of redness, which do not seem to depend upon their vascularity. They not unfrequently contain cysts, and are often partially ossified. Myeloid tumors commonly originate in early adult life, and are usually single, of slow growth, and indolent: the surrounding structures are, as a rule, healthy, though perhaps greatly distended and displaced.

The *diagnosis* from purely non-malignant tumors of bone is rarely possible before operation: when seated on the surface of a jaw (almost the only locality in which it occurs externally), a myeloid may perhaps be distinguished from a fibrous tumor by its greater softness and elasticity.

The *treatment* consists in excision (with the surface of bone from which it grows), or, in the long bones, in amputation at a higher point;[1] as a rule, recurrence is not as much to be feared as with the other tumors of this class, provided that early extirpation has been resorted to. Secondary myeloid tumors have, however, occasionally been met with in the lymphatic glands and in the lungs. Those tumors which present calcareous or osseous nodules are considered by S. W. Gross to be more malignant than others, and he suggests that the mineral salts contained in these nodules may act as carriers of the infecting material which produces the secondary growths.

Sarcoma.—This term is used by Virchow and other German pathologists to designate a group of tumors which possess an analogy "not only with granulations, but also with true flesh of recent formation, or in process of development." (Virchow, *Path. des Tumeurs*, trad. par Aronssohn, t. ii., p. 183.) Connective-tissue tumors "become, under certain circumstances, richer in cells, and enlarge, whilst their interstitial connective tissue becomes more succulent, nay, in many cases disappears so completely, that at last scarcely anything but cellular elements remain. This is the kind of tumor which . . . . ought to be designated by the old name of sarcoma." (Virchow, *Cellular Pathology*, Chance's edit., p. 486.) The following are Virchow's subdivisions of sarcomata, according to their cellular structure:—

FIG. 219.


Trabecular Spindle-cell partly cross cut at *
Large Spindle cell
Giant-cell or Myeloid
Fibro-Sarcoma Trabecular cross-cut at †
Myxo-Sarcoma
Small Spindle-cells
Glio Sarcoma or if with mucous Intercellular Myxo Sarcoma
Large Round-Cell
Small Round cell or Lympho Sarcoma

Several varieties of sarcoma. (BRYANT.)

(*a*) *Reticulo-cellular Sarcoma;* like the typical connective-tissue (fibro-cellular) tumor, but with a larger proportion of cells.

(*b*) *Spindle-celled Sarcoma;* containing fusiform or fibro-plastic cells; corresponds with *fibro-plastic*, *recurrent fibroid*, and *fibro-nucleated* tumors.

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[1] Successful cases of *excision* of the lower ends of the ulna and radius for myeloid tumors of those parts have been reported by Lucas and Morris.

Cells often arranged in lamellæ, bundles, or trabeculæ (*lamellar, fasciculate,* and *trabecular* sarcomata).

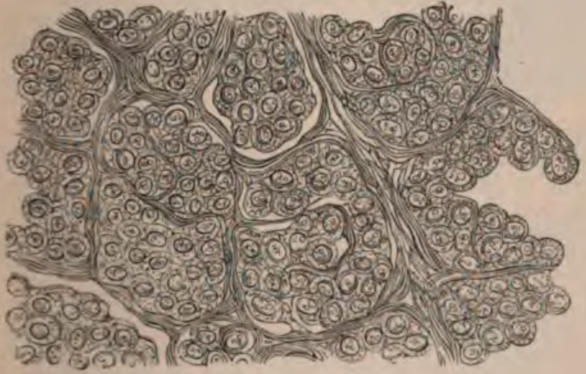
(*c*) *Globo-cellular* or *Round-celled Sarcoma;* often mistaken for medullary cancer, but can be distinguished by observing that the cells of the sarcoma are in constant relation with the intercellular substance, whereas the cancer cells are intimately connected with other cells alone.

Glioma is a variety of round-celled sarcoma, originating in the *neuroglia* or delicate connective tissue of the brain, auditory nerve, or retina. Under the microscope, the tumor is found to consist of round or oval, and sometimes caudate or stellate, corpuscles, with a greater or less amount of a faintly fibrillated stroma. These tumors occur in the outer layers of the retina, in very young children, and, as they grow, cause increased intraocular tension. They may prove fatal by extending backwards within the cranium. Complete and early extirpation of the eyeball is the only treatment to be recommended, though even this will not always prove successful.

(*d*) *Colossal* or *Gigantic-celled Sarcoma;* contains very large cells, with numerous nucleolated nuclei; corresponds with the *myeloid* or *myeloplaxic* tumor.

Billroth also describes an *alveolar sarcoma*, in which the cells are grouped in alveoli, the microscopic appearances of the growth thus closely resembling those of carcinoma; and a *pigmentary* or *melanotic sarcoma*, in which the cells contain pigment matter.

FIG. 220.



Alveolar sarcoma. (BILLROTH.)

If in portions of a sarcoma the process of cell-development is so rapidly carried on that no intercellular substance is formed, those portions become cancerous, and a mixed variety of tumor results, which might properly be called *Carcinomatous Sarcoma.*

The *intercellular substance* in sarcomata usually contains albumen, casein, or mucin (whence another subdivision might be made into *albuminous, caseous,* and *mucous* sarcomata), and, under the microscope, appears *homogeneous, granular,* or *fibrillar.*

Finally, sarcomata are distinguished by the *vascularity* upon which depends their characteristic succulence. They are often the seat of parenchymatous extravasations, these "*hemorrhagic infarctus*" sometimes giving rise to new productions of pigment matter. The *treatment* of the sarcoma consists in excision, but the growth almost invariably recurs, and ultimately leads to a fatal termination. For further information upon the subject of *sarcomata*, the reader is referred to the nineteenth lecture of Virchow's work on Tumors, from which this account has been principally taken.

MALIGNANT TUMORS.

The division of tumors into malignant and non-malignant is, as has been already observed, not perfectly satisfactory; for some of those which, from their structure, we should class as benignant growths, are in their clinical characters almost, if not quite, as malignant as some of those to which we apply the latter name. A *Recurrent Fibroid* may, for instance, run a more malignant course than an *Epithelioma*. The term *Malignant Tumor* is used by Paget, Moore, Pemberton, and other writers, as synonymous with *Cancer*, and *Epithelioma* is by them considered to be merely a variety of cancerous disease. It is, however, upon the whole, better, I think, to separate epithelioma from cancer or carcinoma (from which, indeed, it differs in a good many points), though its clinical characters are such as to make it convenient to retain it among malignant tumors.

Cancer or Carcinoma.—There are two principal forms of cancer, the hard or *schirrous*, and the soft or *medullary*—the terms *melanoid*, *hæmatoid*, etc., being applicable to varieties of these, rather than to distinct and independent forms of cancer. Hard and soft cancer may coexist in the same patient, and even in the same tumor; but they are not interchangeable—that is to say, a mass of scirrhous tissue never becomes medullary, nor *vice versâ*.

1. Scirrhus, or Scirrhous Cancer, is the most common form of cancer, and is more frequenly seen in the female breast than in any other locality, though it also occurs in lymphatic glands, skin, muscle, and bone; in the tongue, tonsils, intestinal canal, lungs, liver, eye, testis, ovary, uterus, etc. Scirrhus is more frequent in women than in men, and occurs more often in persons between forty-five and fifty years of age, than at any other period of life; it is rarely if ever seen in childhood. It is usually supposed that the development of scirrhous cancer is in some way connected with the cessation of the menstrual flow, but statistics do not support such a view. Scirrhus is sometimes predisposed to by *inheritance*, and its development is sometimes directly traceable to the reception of an *injury*, or other local cause. It appears to be proportionally more common among married than among single women. Scirrhus usually occurs in persons who are otherwise healthy, and is at first unattended with much pain; so that it may frequently exist for some time before its presence is discovered.

Course.—Scirrhus originates as a small nodule, and grows with very variable rapidity in different patients, or even at different times in the same patient. Scirrhus is *infiltrated*[1] among the tissues in which it occurs, and increases in size by gradually involving the surrounding structure. Even when to the naked eye, and to the touch, the parts around a scirrhous tumor appear quite healthy, the microscope may reveal the presence of cancer elements, so that scirrhus is said to be often surrounded with a *halo* of cancerous matter.

In its first stage, a scirrhous tumor is, as has been said, very small; indeed, it sometimes renders the part in which it occurs smaller than normal, by inducing contraction of the neighboring tissue. Even in its earliest stage, however, scirrhus has usually its characteristic *hardness*, a peculiarity which is so marked as to have given the disease its name. As a scirrhous tumor grows, it becomes painful, the pain commonly being of a lancinating, "electric" character. Though the growth is in itself not sensitive to the touch, the pain in the tumor is aggravated by handling. As the scirrhous mass in its growth approaches the skin, the latter becomes adherent, the shortening of various subcutaneous fibres giving a *dimpled* or *pitted*, somewhat *brawny* or *lardaceous*, appearance to the part, and, in the case of the breast, inducing *retraction of the nipple*. After a time, *ulceration* occurs, either (1) superficially, when the adherent skin, having become infiltrated and congested, becomes excoriated or cracked, a small, superficial, indolent ulcer resulting; or (2) as the result of disintegration of the cancerous tissue at a deeper point, when a yellowish-gray mass, consisting of cancerous *débris* with ill-formed pus, works its way, abscess-like, to the surface, and is evacuated, leaving an excavated ulcer, which constantly enlarges as the cancer itself grows, and continues to discharge an ichorous and offensive fluid, which often excoriates the neighboring parts. The latter form of ulceration has certain features, such as elevated, knobbed, and everted edges, a hard and nodular base, cancerous walls, and a peculiarly offensive discharge, which, when combined, serve to characterize the so-called *Cancerous Ulcer*. The ulceration of a scirrhous tumor may persist for a long time, and even cicatrization may occasionally occur, the cicatrix being thin, red or livid, with an irregular surface, and much disposed to reulcerate. More commonly the ulcer, as has been said, constantly enlarges, though not so rapidly as the cancer itself; considerable portions of the tumor may become, from time to time, inflamed, and slough, and hemorrhage may occur from the fungous granulations, or from the ulceration invading neighboring vessels, until finally the patient dies exhausted by the profuse and fetid discharge, pain, and loss of blood.

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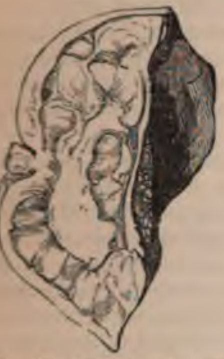
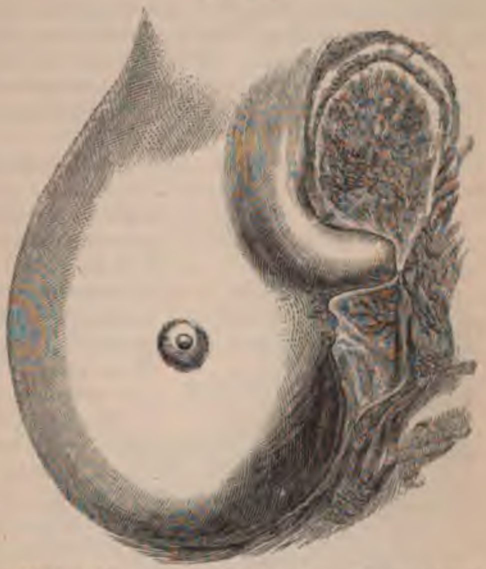
[1] Cullingworth has, however, reported a remarkable case of mammary scirrhus which was completely surrounded by a distinct fibrous capsule. A case of encapsulated scirrhus has also been recorded by Wheeler, of Dublin.

FIG. 221.



Section of scirrhous breast, showing retraction of the nipple. (LISTON.)

FIG. 222.

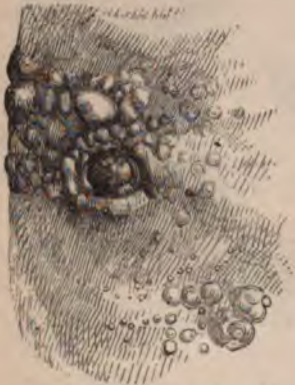


Scirrhus of breast, in stage of ulceration. (From a patient at Episcopal Hospital.)

Scirrhus (which is at first usually solitary) not only grows in the locality in which it first occurs, but becomes diffused, by multiplication, in other parts of the body.[1] The most frequent seat of secondary deposits is unquestionably the lymphatic vessels and glands in the neighborhood of the original tumor; next, in the tissues around, but not immediately connected with, the point of original disease; and lastly, in distant organs, especially the liver, lungs, and bones. T. W. Nunn believes that in cases of *multiple cancer* the disease has originated in the superficial lymphatic plexus, or network, described by modern anatomists, and hence applies to such cases the name of "*lymphatic cancer*." It is occasionally possible to trace the occurrence of secondary cancerous deposits to a process analogous to embolism, but more often the effect only is seen, without the mode of its production being recognizable.

According to Cohnheim and Maas, embolic transference of fragments of malignant and other tumors is constantly going on in patients thus affected, but the embola do not persist and form new growths except in particular states of the constitution; the disease thus remaining a local affection until some deterioration of the patient's health permits the development of secondary growths. Colomiatti believes that cancer sometimes spreads along the *nerves* of a part before the lymphatics become affected.

FIG. 223.



Secondary growths of scirrhus. (MILLER.)

When any of the important internal viscera are affected by secondary cancerous deposits, a marked state of constitutional depression is often produced, which has received the name of *Cancerous Cachexia;* the older writers, indeed, looked upon this *cachexia* as a condition peculiar to cancer, and described it as occurring in almost every case of the disease. Sir Charles Bell's vivid picture is that usually referred to, and the continued emaciation, leaden hue of countenance, pinched features, and livid lips and nostrils, of which he speaks, are undoubtedly seen in cases of scirrhus, but probably not more often than in other exhausting and painful diseases; in fact, while cases of external cancer often run on to a fatal termination without the development of any cachexia whatever, the cachectic state which accompanies internal cancer is not, in itself, distinguishable from that seen in cases of visceral disease of a non-cancerous nature.

To complete the natural history of scirrhus, its *duration* must be briefly referred to: a few cases last ten or twelve years, or even longer, and, the tumor ceasing to grow, and perhaps cicatrizing if ulcerated, the patient may at last die from some other cause. I have myself operated upon persons in whom the disease had lasted six and eight years. The large majority, however (about three-fourths), of patients with scirrhous tumors, die within four years from the time when the growth is first discovered, and the *expectation of life*, as far as figures bear upon the subject, may be said to be about two years and half—as many dying before as after that period. The earlier the age at which scirrhus appears, the more rapid, usually, is its course.

Morbid Anatomy.—When a scirrhous tumor, in its early stage, is cut into, it is found very hard and resisting, and the growth *creaks*, as it is said, under the knife. When laid open, *both the cut surfaces are usually found to be concave*, a very significant feature, and one which, when present, is eminently characteristic of scirrhus. The section is smooth and somewhat glistening, bleeds rather freely at first, is of a pale grayish-white hue, sometimes with a slight purple tint, and is often marked with white or yellow lines and spots. The tumor appears evenly tough and resisting in all directions, and has no distinct margin, being evidently infiltrated into the normal structures of the part. By scraping or pressing the tumor, a grayish-white, gruel-like fluid can usually be obtained, which is diffusible in water, and contains cancerous matter, mingled with the softened tissue of the part, and with the exuded contents of the neighboring vessels; this constitutes the so-called *cancer-juice*, the denser structure which remains being called the *stroma*.

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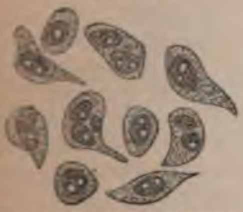
[1] It is often said that the *secondary* growths in cases of scirrhus are of an *encephaloid* nature, and such is occasionally the fact; in most instances, however, the secondary tumors are, as stated in the text, of the same character as the primary growths.

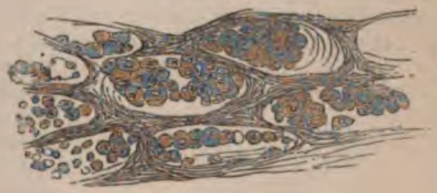
Under the microscope, the cancer-elements may often be seen to be clearly infiltrated among the interstices of the normal tissues of the part. The cancer-elements themselves consist of two parts, viz., a pellucid, dimly granular, or fibrillar *basis-substance*, and somewhat cloudy *cells*, of variable size—usually round or oval, but sometimes angular, caudate, fusiform, lanceolate, etc.—commonly containing one, but often two, large nuclei, and occasionally still more—and frequently mingled with a certain number of free nuclei. The nuclei themselves contain one, two, or even more nucleoli, which are large, bright, and well defined. The size of the scirrhus-cell varies from $\frac{1}{1600}$ to $\frac{1}{700}$ of an inch in diameter, the most usual size being about $\frac{1}{1200}$ or $\frac{1}{1000}$ of an inch; the average length of the nucleus is about $\frac{1}{2500}$ of an inch.

FIG. 224.



Cells from a scirrhus of the mamma. × 250. (GREEN.)

FIG. 225.



Microscopic appearance of scirrhus. (GREEN.)

It is thus seen that there is no distinctive *cancer-cell;* the nature of the growth is to be recognized by the great *multiplicity of forms* seen in the same specimen, and by the fact that the cells are closely packed together in groups, without the intervention of any recognizable intercellular substance.

Beside these, which may be regarded as the normal elements of scirrhous cancer, cells are often seen which are withered, or in various stages of degeneration; the cells may be shrivelled, containing oil globules and granular matter, or may be completely disintegrated, the nuclei being set free, and appearing to be mingled with granular matter and molecular *débris*. In addition to the cancerous elements themselves, a scirrhous tumor shows, under the microscope, various structures, glandular, muscular, fibrous, areolar, etc., which belong to the tissues in which the cancer happens to be growing, and which are present in varying quantities, being least apparent when the cancer-structure itself is most abundant.

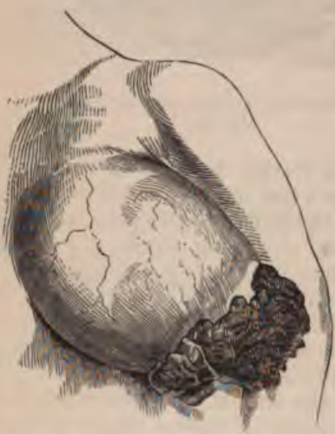
The anatomical characters of scirrhus, when occurring as a secondary deposit, as, for instance, in the lymphatic glands, do not differ in any essential respect from those above described. The surface, however, does not commonly become concave on section, nor are the white fibrous lines so well marked as in the primary tumor.

Scirrhus, in some cases, appears as a spreading, comparatively superficial affection, rather than as a tumor: it is thus met with on the surface of the thorax, sometimes originating in the skin itself, at other times in the mammary gland, or as tubercles in the deeper planes of tissue, but always at last involving both superficial and deep structures, and surrounding the chest with a mass of cancer, appropriately called, by the French, cancer "*en cuirasse*." The course of this form of scirrhus is often extremely chronic, patients living in this condition for over twenty years, in spite of the pain and occasional hemorrhages which attend the disease when ulceration is present; partial cicatrization even sometimes occurs, giving the part somewhat the appearance of a serpiginous chancroid.

Under the name of *Acute Scirrhus*, many writers describe a form of the disease in which the tumor is less hard and more elastic than in ordinary scirrhus, does not appear concave on section, is more succulent, has usually smaller cells, grows more rapidly, and altogether runs, as the name implies, a quicker course than the average. Acute scirrhus occurs at a comparatively early age, and forms to a certain extent a connecting link with medullary cancer.

2. Medullary or Soft Cancer (**Encephaloid**) is so called from its often presenting a brain-like appearance when laid open. It occurs in the uterus and other internal organs, in the testis, eye, bones, intermuscular spaces, mammary gland, lymphatics, etc. It is rather more frequent in women than in men (though less markedly so than is the case with scirrhus), and may occur at any age, more than one-fourth of the whole number of cases of external medullary cancer being met with in persons under twenty, and nearly two-thirds in those under forty. The influence of inheritance is about as well marked in medullary as in scirrhous cancer, while the proportion of cases in which previous injury is supposed to act as an exciting cause is nearly twice as great. The victims of encephaloid are less often in robust health, before the appearance of the disease, than are those affected with scirrhus.

FIG. 226.



Medullary cancer in stage of ulceration; tumor protruding. (DRUITT.)

Course.—Medullary cancer appears as a *solitary* growth, except in the subcutaneous tissue, where it is often *multiple*. I had under my charge in the wards of the Episcopal Hospital, some years since, a man fifty-one years old, who, beside a large encephaloid tumor of the left shoulder, had smaller masses of the same kind upon the neck, chest, abdomen, back, arms, and thighs. The growth of medullary cancer is commonly very rapid, sometimes, according to Paget, exceeding a pound per month. On the other hand, cases are occasionally met with in which the growth of medullary cancer is spontaneously arrested, the tumor remaining without change for a number of years. Medullary cancer may occur, like scirrhus, as an ill-defined infiltration, or as a distinct tumor invested by a tolerably complete capsule. It has no tendency to draw in adjacent parts, as scirrhus does, but distends and displaces them. The skin over a medullary cancer becomes thin and tense, and finally gives way, just as it would in the case of any other rapidly-growing tumor, so that the ulceration over a mass of encephaloid presents none of the peculiar characters which have been described as belonging to the "cancerous ulcer." When ulceration has occurred, however, the cancer, being freed from the restraining pressure of the skin, appears to grow with increased rapidity, and soon protrudes through the opening—the exuberant mass usually becoming inflamed, sloughing, and bleeding, and constituting the bleeding fungus, or *Fungus Hæmatodes*, of the older writers. Medullary cancer occurring in bone is sometimes attended with a distinct pulsation (see p. 490).

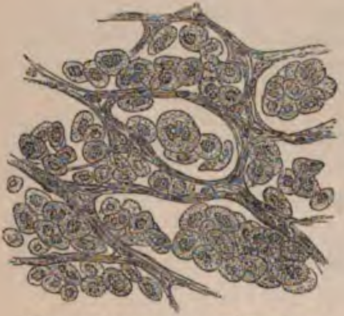
The course of medullary cancer is commonly towards an early death, but occasionally—even after ulceration—large masses of encephaloid matter may slough away, cicatrization following, and thus leading to at least a temporary recovery. Medullary cancers sometimes *wither*, becoming shrivelled and concentrated, and finally temporarily disappearing; in other cases they undergo *fatty degeneration*, ceasing to grow, and becoming "obsolete." Usually, however, while this change occurs in one tumor, others continue to increase. *Calcareous degeneration* is a rare occurrence, and, when seen, is usually combined with the fatty change above referred to. The occurrence of hemorrhage and of sloughing in medullary cancer has been already mentioned. More rarely, inflammation of such a growth ends in suppuration, and in this way, too, temporary disappearance of the tumor may be effected.

Medullary, like scirrhous, cancer tends to *multiplication* in various parts of the body, and there is reason to believe that, in many cases, fragments of the primary growth are detached and carried by the general circulation to remote organs, where they lodge and grow as independent centres of disease. The *pain* of medullary cancer is usually much less than that of scirrhus; indeed, when pain is observed, it appears to be referable to the organ affected, rather than to the diseased mass itself. The general health fails in many cases of medullary cancer more rapidly than can be accounted for by the amount of disease. The *cachexia* thus caused does not appear, however, to be of any specific constitutional nature, for it often rapidly disappears when the morbid growth is removed, the patient quickly regaining flesh and strength. The average *duration* of medullary cancer is decidedly less than that of scirrhus, more than three-fourths of those affected dying within three years, and the *expectation of life* being, in general terms, not more than a year and a half.

Morbid Anatomy.—Medullary or *soft* cancer is, as its name implies, commonly a soft, compressible tumor, giving a deceptive feeling of fluctuation, though it is sometimes comparatively firm and elastic, approximating in character to the acute variety of scirrhus. The tumor has a rounded or oval outline, but is often markedly lobated, the lobes extending through muscular, fibrous, or bony interspaces, to a considerable distance from the position of the principal mass. These outlying projections are apt to acquire deep attachments, or may surround and inclose important structures, such as the carotid artery, jugular vein, or phrenic nerve. The superficial veins, over a soft cancer, are usually enlarged and tortuous.

When a medullary cancer is surrounded with a capsule, the latter, which is of thin connective tissue, often sends in septa, which may separate the lobes of the tumor, or, if it be not lobated, merely traverse its substance. The capsule is vascular, tense, and may or may not be adherent to surrounding structures. When cut into, the contained tumor protrudes, or, if very soft, oozes out like a thick fluid. When laid open, a medullary cancer has commonly a lobated appearance, the various lobes, with their investing septa, being often distorted by mutual compression, and having the appearance of a mass of cysts filled with intra-cystic growths. The substance of a medullary cancer varies in color, being usually grayish-white, but sometimes tinted with yellow, pink, or violet. In the softer tumors, it has but little consistency, being friable or pulpy, like softened brain-matter, or grumous and shreddy; while in the firmer varieties, it is compact and resisting, is somewhat glistening on section, and occasionally presents a fibrous appearance. By pressing or scraping a medullary cancer, a considerable quantity of a turbid, creamy "cancer-juice" is obtained, which is readily diffusible in water—the "stroma" which remains being in comparatively small amount, and appearing filamentous, spongy, and quite vascular. The structure of the infiltrated form of medullary cancer does not differ essentially from that above described.

FIG. 227.



Microscopic appearances of medullary cancer. (GREEN.)

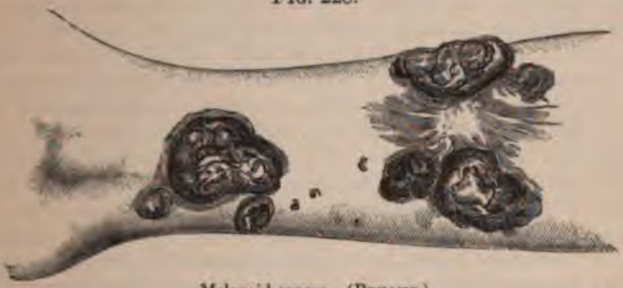
The microscopic appearances of encephaloid are even more variable than those of scirrhous cancer. The normal or typical form of the medullary cancer corpuscle is a nucleated cell, closely resembling that seen in scirrhus, but differing in its mode of arrangement—the cells in encephaloid being not closely packed together, but loosely aggregated in a comparatively soft or fluid basis-substance. The following are among the chief variations observed in the corpuscular structure of medullary cancers: (1) there may be free nuclei, with few or no cells, scattered through a nebulous or granular basis-substance: the nuclei are usually oval, $\frac{1}{2500}$ to $\frac{1}{2000}$ of an inch long, bright, well defined, and containing large and often double nucleoli; (2) large elongated or caudate nuclei, containing granular matter, or one or more large nucleoli; (3) large round or oval nuclei, resembling lymph corpuscles, and containing numerous shining granules, but no distinct nucleoli; (4) very numerous elongated and caudated cancer cells, resembling the cells of the recurrent fibroid tumor, and giving the mass a fibrous appearance on section; (5) large round cells, containing granules, and either no perceptible nucleus, or one which is smaller and more granular than that of the ordinary cancer cell; and (6) multi-nucleated cells, or parent cells containing numerous smaller cells. These various forms of cancer corpuscle may simply float in a turbid liquid, which is sometimes called "cancer-serum;" in other cases, this liquid is itself diffused through the interspaces of a spongy basis-substance, which may be homogeneous, may present imbedded nuclei, or may have a fibrillated appearance; while in other cases, again, there may be a distinct framework, or skeleton, of delicate filamentous, fibro-cellular, fibrous, or even osseous structure.

Still further variations in appearance are caused by the occurrence of fatty degeneration, giving rise to yellow, scrofulous-looking masses, or by the intermingling of cartilaginous, cystic, or other morbid growths.

3. Other Varieties of Cancer.—Of the other forms of cancer mentioned in the classification on page 473 I shall say but little, as they are comparatively rare, and are indeed probably but modifications of those already described.

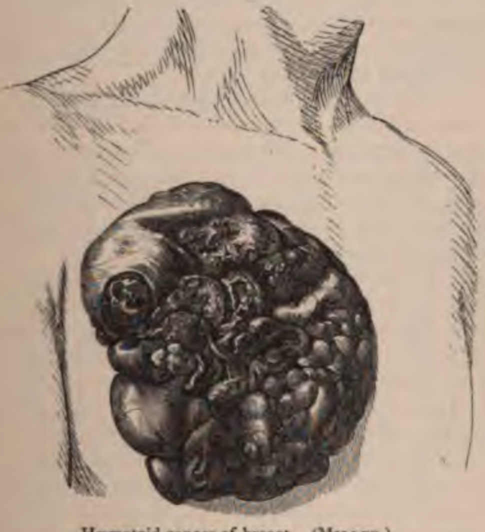
Melanoid or *Melanotic Cancer* is medullary cancer, with the super-addition of black pigment in the elemental structure of the growth; it bears the same relation to ordinary encephaloid that the *pigment* or *melanotic sarcoma* does to the other varieties of that group of tumors (p. 493), or that melanoid does to ordinary epithelioma. Melanotic cancer usually occurs as a separable mass, rather than as an infiltration, and its favorite localities are the skin and subcutaneous tissue. The pigment is commonly in the form of granules or molecules, but may occur in larger nucleus-like corpuscles; it corresponds with the normal pigment of the choroid coat of the eye, with that of the rete mucosum in the black races, and with that found in the lungs and bronchial glands of old people. The course and natural history of melanotic cancer are very much those of encephaloid; it has, however, a still greater tendency to spread, by multiplication, in the subcutaneous tissue, as well as to involve internal organs. It is peculiarly apt to grow beneath pigmentary cutaneous moles.

FIG. 228.



Melanoid cancer. (BRYANT.)

FIG. 229.



Hæmatoid cancer of breast. (MILLER.)

Hæmatoid Cancer is simply cancer (usually medullary) which contains clots of blood, the result of interstitial hemorrhage; when protruding through ulcerated skin, it constitutes the *Fungus Hæmatodes* of Hey, Wardrop, and others (Fig. 229).

Osteoid Cancer.—"I believe," says Paget, "the most probable view of the nature of osteoid cancers would be expressed by calling them ossified fibrous or medullary cancers, and by regarding them as illustrating a calcareous or osseous degeneration."

Osteoid cancer usually occurs in bone (particularly in the lower part of the femur), but is also seen in the intermuscular spaces, the lymphatic glands, etc. When met with in bone, it may occupy either the interior or exterior, or both, and has usually an elongated oval or bi-convex shape, according to the nature of the bone in which it occurs; it has a smooth surface, is hard, nearly incompressible, painful, and often tender when touched. The bony part of the tumor is, as it were, infiltrated into that part which is unossified, and differs from ordinary bone in being chalk-like and pulverulent, in having small and irregular bone corpuscles, in containing no medulla (its interspaces being filled with cancer-matter), and in having an undue proportion of phosphate of lime. It is extremely compact in its central portions, and nodulated at its periphery, the nodules being often formed of closely-set lamellæ, with edges directed outwards. The unossified part of the tumor is very hard, tough, and incompressible, and, under the microscope, appears homogeneous (abundant nuclei being made apparent by the addition of acetic acid), or may present fibres of various sizes, and variously arranged, mingled with ordinary cancer cells, granule-masses, and oil globules.

Osteoid differs from other forms of cancer in being most frequent in the male sex, and in persons under thirty years of age; its development is often traceable to a previous injury. The course of osteoid cancer is rapid and painful, with multiplication in lymphatics and in distant parts, and early occurrence of constitutional disturbance or cachexia. Death usually occurs within the first year of the disease; but two instances are mentioned by Paget in which, after removal of the primary growth, life was prolonged for twenty-four and twenty-five years, respectively. When early death occurs, it is due to the development of secondary growths, which are sometimes of the nature of ordinary medullary cancer.

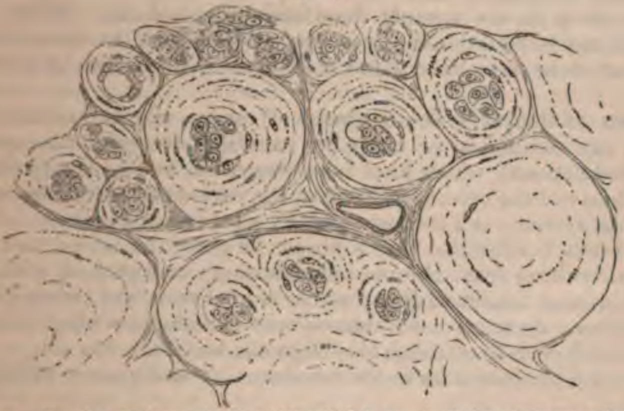
Villous Cancer.—Under this name have been included many innocent growths which have a villous or papillary structure (see page 489), as well as a villous or warty form of epithelioma. The term villous cancer may still, however, according to Paget, be properly used for certain growths, met with chiefly in the urinary bladder, which have a stroma presenting what Rokitansky calls dentritic vegetation, the interstices being filled with the ordinary cell-forms of medullary cancer.

Colloid, or, as it is also called, *Alveolar* or *Gum Cancer*, occurs as a primary affection, chiefly in the alimentary canal, uterus, mammary gland, and peritoneum. It is also met with, as a secondary growth, in the lymphatic glands, lungs, and other parts of the body. Colloid cancer consists of a stroma of more or less delicate white fibrous tissue, forming alveoli or cysts of various sizes, which contain the colloid matter. The fibres of this stroma, under the microscope, often exhibit elongated nuclei, and sometimes elastic fibres are mingled with them. The colloid substance itself generally appears structureless, but contains corpuscles, consisting (according to Lebert, as quoted by Paget) of (1) cells, free, inclosed in mother-cells, or grouped like an epithelium—these small cells ($\frac{1}{5000}$ to $\frac{1}{2000}$ of an inch in diameter) being granular, of irregular shape, and containing small nuclei, if any—they are probably ill-formed cancer cells; (2) large oval, round, or tubular mother-cells, $\frac{1}{500}$ to $\frac{1}{250}$ of an inch in diameter, sometimes with a lamellar surface, and containing one or more nuclei, with granules, and sometimes complete nucleated cells; and (3) large laminated spaces, $\frac{1}{100}$ to $\frac{1}{50}$ of an inch in diameter, with elongated nuclei between the lamellæ of their walls, small nucleated cells and nuclei in their interspaces, and brood-cells in their internal cavities.

The diversity in structure between colloid and other cancers is attributed by Paget, and, apparently, with good reason, to the occurrence of colloid cystic disease in ordinary encephaloid growths.

Colloid cancer occurs as an infiltration, and sometimes attains an enormous size, particularly in the peritoneum. Its course is much the same as, though rather slower than, that of medullary cancer.

Fig. 230.



Colloid cancer. Showing the large alveoli, within which is contained the gelatinous colloid material. × 300. (Rindfleisch.)

Fibrous Cancer is the name adopted by Paget, in the last edition of his classical lectures on Surgical Pathology, for those rare cases of fibrous tumor which run a malignant course, and which have already been referred to under the name of *Malignant Fibroid* (p. 484).

Nature of Cancer.—I do not purpose to enter into any discussion as to the *Nature and General Pathology of Cancer,* but would refer the reader for information upon these topics to Sir James Paget's lectures, and to Mr. Moore's essay in Holmes's System of Surgery, where will be found very fully and ably set forth the facts and arguments which bear upon the subject.[1] Mr. Moore, as is well known, was a prominent advocate of the "local origin" theory of cancer, while Sir James Paget, after mature consideration of the whole subject, adheres to the doctrine of a cancerous diathesis. That a local cause, traumatic or otherwise, can, without any previous predisposition on the patient's part, give rise to the formation of a cancer, it is hard to believe; at the same time, cancer may undoubtedly (from a practical point of view) be looked upon as, at first, a local affection—its early manifestations being of a local nature, and the only applicable treatment being of a topical character; even when "cachexia" precedes the appearance of a cancerous tumor, the removal of the latter may relieve, at least temporarily, the cachectic condition. With regard to the *anatomical origin* of cancer, the prevailing views are: (1) that of Virchow, who believes that the cancer-cells originate in a transformation of connective-tissue corpuscles; (2) that of Thiersch and Waldeyer, who maintain, on the other hand, that cancer can only originate in tissue of an epithelial type; (3) that of Maier, of Freiburg, who holds an intermediate opinion, believing that fibrous growths may be transferred into sarcomata, and these in turn into true cancers;[1] (4) that of Koester, who believes that the cancer-cells are derived from the endothelium of the lymphatics; and (5) that of Classen, Woodward, and Thin, who regard them as altered white blood corpuscles which have migrated from the bloodvessels in the manner described by Cohnheim. While none of these views can be considered as positively established, the second and fifth are those which seem to have found most favor with modern pathologists.

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[1] See also the works of Virchow, Billroth, and Rindfleisch, Dr. J. J. Woodward's "Toner Lecture" (1873), and an interesting paper on the Development of Cancer, published by Waldeyer in Virchow's *Archiv,* and analyzed in the *Archives Générales de Médecine* for October, 1873.

Diagnosis of Cancer.—The *diagnosis* of cancer, whether scirrhus or encephaloid, can commonly be made by carefully observing the symptoms, physical and rational, which have been described, and by comparing these, and the history of the case, with those of the various forms of non-malignant tumor—thus arriving at a correct result by a process of exclusion. Scirrhus is most apt to be confounded with a fibrous or glandular tumor, and with the induration resulting from chronic inflammation; encephaloid, with a fatty, cystic, or vascular tumor, with chronic or cold abscess, and (when pulsating) with aneurism. In many cases, microscopic examination after removal can alone be relied upon to establish the diagnosis, and even this will not always afford certain information as to the innocence or malignancy of the tumor.

Prognosis.—The *prognosis* of cancer is always unfavorable: in the very large majority, if not in all cases, the disease will terminate in death in spite of treatment, which, however, will often serve to prolong life, and to render the condition of the patient comparatively comfortable—and death, when it does occur, comparatively painless—and may even postpone the fatal termination indefinitely, the patient dying, without return of the disease, from some intercurrent affection.

Treatment of Cancer.—The *General Treatment* of cancer consists in the adoption of such measures as may be required to maintain the general health. The diet should be mild but nutritious, and the patient should be placed in the best possible hygienic conditions. Tonics, and especially cod-liver oil and iron, may be advantageously administered, the latter, according to Mr. Moore, preferably in combination with chlorine. Arsenic has been very favorably spoken of by Esmarch, Tholen, Parker, of New York, and W. L. Atlee, of this city, and silica has been recommended by Mr. Fawcett Battye, of London. Chian turpentine has recently been vaunted as a remedy for cancer, but the evidence in its favor is at least open to question. Anodynes are of great service, particularly in the later stages of cancer, when the greatest comfort may be often afforded to the patient by the repeated use of hypodermic injections of morphia. The pain of *inflamed* cancer is, according to Paget, often due to coincident gout, and may be relieved by the administration of dilute liquor potassæ, a favorite remedy of Brodie's in these cases.

The *Local Treatment* may be palliative, or may aim at eradication of the disease. As a *palliative* measure, the part should be protected from external irritation by being covered with a layer of cotton-wadding, or with a soft and well-fitting plaster, which may be medicated with opium, belladonna, or any other anodyne that may seem appropriate; the application of a freezing mixture, as recommended by Arnott, may occasionally serve to retard the progress of the disease. When ulceration is present, the part should be kept clean, and may be dressed with a solution of the permanganate of potassium, of chloral, or of carbolic or acetic acid; the injection of the latter acid into the cancerous mass itself has been advised by Broadbent, under the impression that it might dissolve the cancer-cells, but the plan has not been found generally useful. The injection of alcohol is recommended by Schwalbe and Hasse. If hemorrhage occur from the ulcerated surface, it may be checked by the use of the persulphate of iron. *Compression*, by means of gum-elastic pads or other contrivances, has been extensively used by Récamier and others, and appears to be sometimes effective in controlling pain, though it is extremely doubtful if it have any really curative influence. The same may be said with regard to the use of *electricity*, which has lately excited a good deal of attention as a remedy in these cases.

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[1] According to Maier and Creighton, the *essence* of cancer consists in its property of *infecting* the neighboring tissues; thus a growth which, while confined to a glandular organ, and retaining in structure and function the type of the normal tissue, is an adenoma, becomes cancerous as soon as it infects the adjoining tissues.

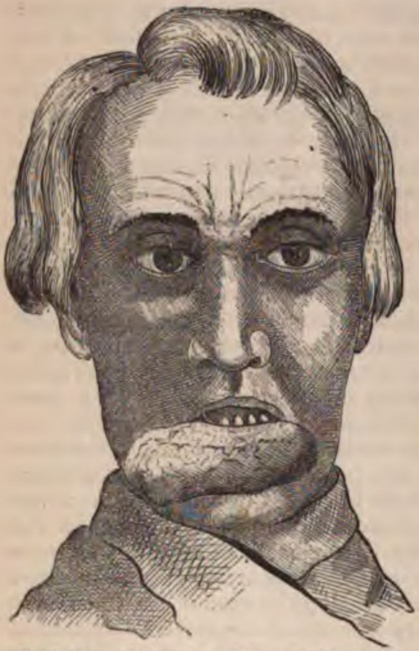
The *Radical Treatment* of cancer consists in removal of the morbid growth, by the use of the knife, or by the application of caustics. *Caustics* are only to be recommended in cases of ulcerated cancer, in which, from the superficial extent of the disease, or from its locality, the operation of excision is contraindicated. Various substances have been used as cauterizing agents, such as arsenious, nitric, or sulphuric acid, the caustic alkalies (especially the "Vienna paste," or *potassa cum calce*), and mineral salts, of which the best is probably the chloride of zinc. This may be diluted with four or five parts of flour, and made into a paste with water (*Canquoin's paste*), being then laid upon the denuded surface, and allowed to remain from six to twenty-four hours, according to the intensity of the effect desired to be produced; a slough having been formed, this may be deeply incised, and the caustic reapplied. Another mode of using the chloride of zinc is by introducing the caustic, in the form of arrows, concentrically around the circumference of the tumor (*cautérisation en flèches*), as recommended by Maisonneuve—or a caustic solution may be hypodermically injected, as recommended by Sir J. Y. Simpson, and more recently by Richet. Delahousse has employed the actual cautery as a modification of Maisonneuve's method.

Excision (or amputation, if this operation be from the position of the cancer considered preferable) is the mode of treatment to be chosen in any case in which it is practicable. The propriety of resorting to excision, in suitable cases of cancer, is shown by the following circumstances: (1) it is at least *possible*, if unlikely, that a permanent cure may be obtained; (2) if the disease return, it will probably run a more chronic, or, at any rate, a not more acute course, than if the cancer had not been removed; (3) the average duration of life is shown by statistics to be increased by operation, from one to two years in the case of scirrhus, and from four months to a year in the case of encephaloid; (4) there is reason to hope that if the disease return after operation, it may do so in some internal organ, when its course and termination will be comparatively painless; and (5) even if the recurrence of the cancer be inevitable, a temporary interval of comfort and usefulness will have been secured to the patient—an interval which in favorable cases may extend to several years.

The propriety or impropriety of operating in any particular case depends much upon the locality of the cancer, and the age, general condition, etc., of the patient. But in general terms it may be said that, in the case of a primary growth, an operation is called for, *provided that the entire mass of diseased structure can be safely removed.* *Adhesion* to either the skin or subjacent structures, *ulceration*, or even moderate *lymphatic complication*, though unfavorable features, are not in themselves contra-indications. If, however, the disease be so extensive that the probability of its being thoroughly extirpated is doubtful, if there be multiple tumors, if the skin be widely infiltrated, or if the deep-seated lymphatic glands, or internal viscera, be evidently involved, the operation can rarely be deemed justifiable. *Sciatic pain* is regarded by DeMorgan as strongly significant of general contamination of the system, and in the case of melanotic growths, visceral implication may, according to Nepveu, be recognized by the discovery of pigment matter in the blood and urine. If, from the age of the patient, the size or locality of the tumor, or any other circumstance, the operation should be in itself likely to be attended with unusual danger, excision should not as a rule be practised—the prospective benefits, in such a case, being insufficient to counterbalance the risks of treatment. Operations for *rapidly growing* cancers are less likely to be attended with benefit than when the disease is chronic, but such cases are precisely those in which operative interference is most urgently demanded. Cases of very chronic and indolent, *atrophic cancer*, as it is sometimes called, may, indeed, do better occasionally without operation; but these cases should be constantly watched, and the tumor should be removed on the first manifestation of active growth. In all other cases, if an excision is to be done at all, it should be done as *early as possible;* not only is the operation in itself thus less dangerous, but the chances of permanent benefit are much greater than if the operation be delayed.

Recurrent Cancer may be removed by operation under the same circumstances which justify excision of the primary growth.

FIG. 231.



Epithelioma of lower lip. (From a patient in the University Hospital.)

Epithelioma, or, as it is called by Paget and others, *Epithelial Cancer*, is usually met with in, or immediately below, the skin or mucous membrane, and very commonly at points where these structures join each other, its most frequent locality being the muco-cutaneous surface of the lower lip. It also occurs in the tongue, prepuce, penis, scrotum, labia, and nymphæ, and more rarely at the anus, in the buccal mucous membrane or upper lip, in the mucous linings of the respiratory, alimentary, and urino-genital tracts of either sex, the skin of various parts, the lymphatic glands, bones, dura mater, etc. From its primary seat it spreads, involving in its growth any structures with which it meets. When it occurs as a secondary affection, it may be in the neighborhood of its original position, but more often in the proximal lymphatic glands. It is occasionally, but rarely, seen in the internal organs, such as the liver, lungs, and heart. Epithelioma is most frequent in the male sex, and rarely occurs before middle life, the liability to its development appearing indeed to increase with the advance of years. Inheritance is rarely traceable in this form of disease, while a large proportion, probably a majority, of cases appear to have originated from an injury or other local cause. Thus epithelioma of the lower lip is often attributable to the habit of smoking a short pipe; in the tongue, the disease may originate from the irritation caused by an uneven tooth; in the extremities, it is seen in the seat of old ulcers; while in the scrotum of chimney-sweepers, it is produced by the irritating contact of soot. It frequently occurs in the seat of indurated and incrusted warts. Epithelioma, following chronic inflammation, is also seen in the so-called "tar-cancer" which occurs in the workmen employed in coal-tar and paraffine manufactories.

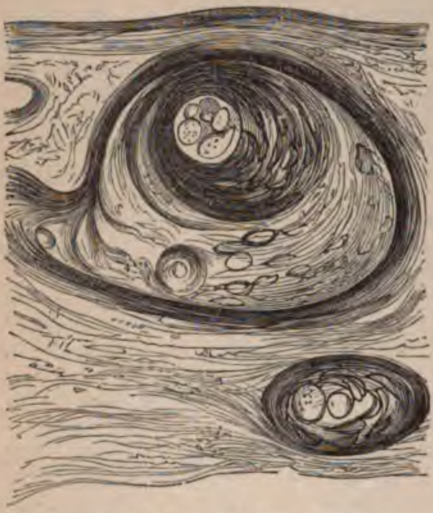
Course.—Epithelioma is usually single, and in most cases runs its course in from eighteen months to three years. The duration of the disease varies a good deal with its locality, epitheliomata of the tongue and penis being commonly the most, and those of the scrotum and lower extremities the least, rapidly fatal examples of the disease. Ulceration occurs at an early period, and gradually spreads, involving the superficial, and sometimes the deep, lymphatic glands, and leading to a fatal result by inducing gradual exhaustion, without the development of any special cachexia, and, as a rule, without the occurrence of secondary deposits in other parts.

Morbid Anatomy.—Epitheliomata may occur as *superficial, flat,* or *exuberant growths*, in which case they occupy the cutaneous or mucous structures themselves, involving the papillæ to a greater or less degree; or as *deep-seated, flat,* or *rounded tubercles*, when they occupy only the subcutaneous or submucous tissues. When first seen by the surgeon, the superficial form of epithelioma may appear as a warty excrescence, which soon undergoes ulceration, or as a fissure or small ulcer covered with a dry scab, and with deeply indurated base and edges. The warty epithelioma sometimes assumes a truly *villous* form, and has been regarded as a variety of *villous cancer* (see page 502). The deep form of epithelioma (which is very rare) appears as a round, firm, somewhat elastic tumor, over which the skin or mucous membrane is more or less tightly stretched, finally giving way, and allowing the mass to protrude. Intermediate varieties are more common, in which both integument and subjacent structures are simultaneously involved. Though, however, the differences between these forms of epithelioma may at first be well marked, they usually soon disappear, the superficial variety tending to involve the deeper structures, while the deep form of the disease may, at a late period, become exuberant. Occasionally epitheliomata are quite prominent, forming sometimes even pedunculated and pendulous tumors.

The *epitheliomatous ulcer*, whether originating as a superficial excoriation or as a fissure, gradually tends to assume a uniform character. It is usually excavated, oval or elongated, and with hard base and edges. Its surface is uneven, nodulated or warty, florid, and disposed to bleed; it furnishes an ichorous and very offensive fluid, which tends to form dark-colored crusts or scabs. The general form of the ulcer resembles the "cancerous ulcer" of scirrhus; the induration varies from a line to half an inch or more in thickness, and is due to the infiltration of epitheliomatous material.

A vertical section of an ordinary epithelioma shows at the upper border a scab, or, if this be detached, a whitish slough-like layer, consisting of loosely aggregated epithelial scales, which have been detached from the deeper structures, and which may be readily removed by washing. The main substance of the growth has commonly a somewhat shining, grayish-white hue, is close-textured, firm and rather elastic, and occasionally presents a striped appearance due to its papillary structure. Squeezing or scraping brings out a curdy, yellowish-white material, which resembles the comedones or sebaceous contents of hair-follicles, and which, according to Paget, unlike "cancer-juice," does not readily become equably diffused when mixed with water. This distinction is, however, wanting in the case of very soft epitheliomata. Epithelioma is *infiltrated* into the tissue in which it occurs, and the normal structures can therefore often be traced into the epitheliomatous mass.

FIG. 232.



Concentric globes of epithelioma. (GREEN.)

Under the microscope, the characteristic structures of epitheliomata are found to consist of (1) *cells*, which are nucleated, flattened, and scale-like, much resembling the ordinary epithelial cells (whence the name of the disease), from $\frac{1}{1233}$ to $\frac{1}{200}$ (usually $\frac{1}{700}$) of an inch in diameter, and containing a few granules, and a clear, round or oval, well-defined *nucleus* (about $\frac{1}{3500}$ of an inch in diameter), which itself contains granules, but rarely a distinct nucleolus; the cells assume very various forms, being sometimes wrinkled, caudate, or elongated, sometimes without nuclei, and sometimes filled with oily particles, as if from fatty degeneration; (2) *nuclei*, free or imbedded, most abundant in the most acute cases, sometimes like the nuclei seen in the epitheliomatous cells, but sometimes larger, with more distinct nucleoli, and much resembling the nuclei of scirrhous or medullary cancer (see pages 497 and 500); (3) *brood-cells*, or cells containing nuclei undergoing development into nucleated cells, the successive formation of one cell within another sometimes giving a peculiar laminated appearance; and (4) *laminated capsules*, *nests*, or *epidermic* or *concentric globes*, consisting of concentric layers of epithelial scales, containing in the central space granular or oily matter, cells, or free nuclei, and apparently resulting from a continuation of the process of endogenous cell-formation described as giving a laminated appearance to the simpler brood-cells. These nests or concentric globes are met with in other epidermic formations, but are better marked in epitheliomatous than in any other structures.

The cells of epithelioma above described vary with the nature of the surface in which the growth occurs; thus, while in the lower lip they resemble the cells of ordinary tessellated epithelium, in the mucous membrane of the intestine they have a cylindriform appearance. Very rarely, melanoid matter is mingled with the epitheliomatous structure, constituting the *melanotic* form of the disease.

Diagnosis.—The diagnosis of epithelioma from scirrhous and medullary cancer may usually be made by observing its locality—commonly a mucous or muco-cutaneous surface—its frequent origin from sources of local irritation, its early and wide-spreading ulceration, and the absence of any tendency to involve distant organs, or to produce a cachectic condition. When occurring on the fingers, lips, or tongue, epithelioma may occasionally be mistaken for a chancre in the same situation. In any case of doubt, the patient should be submitted to antisyphilitic treatment, the effect of which will usually suffice to make the nature of the case apparent.

Prognosis.—The prognosis of epithelioma, when promptly treated, is much more favorable than in the case of other malignant tumors. The average gain of life by operation is about two years and a half, and several authentic cases are on record in which no recurrence of the disease was observed for twenty or even thirty years after excision of the primary growth. The late Mr. Collis, indeed, went so far as to declare that no recurrence (in the case of epithelioma of the lip) was to be anticipated, provided that excision was thorough, and that caustics had not previously been used.

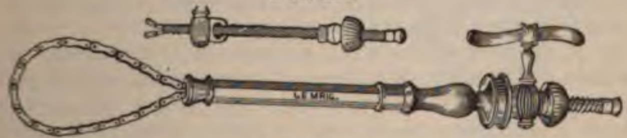
Treatment.—As a rule, it may be said that glandular complication, if extensive, should forbid operation in cases of epithelioma. If, however, the neighboring lymphatic glands be enlarged and irritated merely, without being infiltrated, or if the glands, though infiltrated, can themselves be removed, an operation may be proper, though, in such a case, the prognosis should always be very guarded. Constitutional treatment, except such as may be required by the general state of the patient, is as useless here as in the case of cancer; the only hope is in complete extirpation of the epitheliomatous mass; and this, to be successful, should be done at as early a period as possible. The treatment may consist of excision, strangulation, or the use of caustics.

Caustics are only to be recommended when, from the locality or superficial extent of the epithelioma, the use of the knife would seem to be contra-indicated. The best caustics are probably the potassa cum calce, chloride of zinc, and acid nitrate of mercury. According to Busch, the use of alkaline lotions, especially a solution of soda, may occasionally effect a cure in the early stages of the disease. Pillate, of Orleans, recommends the chlorate of potassium, but there seems to have been some doubt as to the real nature of the affection in the cases reported by this surgeon.

Excision is the mode of treatment to be preferred whenever it is practicable. The incisions should be carried wide of the diseased structure, and may be so arranged as to allow of the extirpation of any glands that it may be thought proper to remove. In certain situations, as in the hand or lower extremity, the extent of the disease may be so great as to render amputation a better operation than simple excision.

Strangulation may occasionally be required, if the locality of the epithelioma be such as to forbid excision, or if the part be so vascular as to cause fear of hemorrhage. In such a case, the part to be removed may be insulated by means of two or more strong *ligatures*, when it will slough, and become detached in the course of a few days, or removal may be effected by means of the *elastic ligature*, as recommended by Dittel, of Vienna; in other situations, as in the tongue, the process introduced by Chassaignac, and known as *Écrasement linéaire*, will be preferable. One or more *écraseurs* may be used, the chain of the instrument being passed, if necessary, through the base of the growth by means of a needle. The screw should be slowly worked, and the handle turned not more than once in fifteen seconds.

FIG. 233.



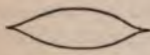
Ecraseur.

Recurrent Epithelioma may be treated in the same manner as the primary growth.

Excision of Tumors.

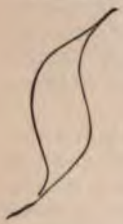
No rules of universal application can be given as to the mode of excising morbid growths. It may be said, however, in general terms, that the incision (for, in the case of innocent growths, there should usually be but one) should be in the direction of the long axis of the tumor, and should correspond as far as possible with the natural folds of the part. In the case of non-malignant tumors, no skin need be removed, unless the growth be very large; but if the tumor be malignant, it will usually be necessary to remove a portion of the cutaneous investment, whether it be or be not ulcerated, and the incisions in this case may be elliptical (Fig. 234), or in the form of a double S (Fig. 235).

Fig. 234.



If the tumor be encapsulated, it should be removed if possible by enucleation, the finger and handle of the knife being used in the deeper parts, instead of the cutting edge of the instrument: when it is necessary to resort to dissection, the growth should be loosened first at the part at which its main vessels enter, so that if these are cut, they they may be secured once for all.[1] In removing a *non-malignant* growth, the knife should be kept close to the tumor, so as to avoid wounding the important structures to which it may be attached, but if the growth be *malignant*, the surgeon should keep wide of it, in all his manipulations, so that no portion may be allowed to remain. If possible, a tumor should never be cut into until it is removed: neglect of this precaution may lead to hemorrhage (for the tumor itself may be very vascular), and if it be a malignant growth, particles may escape from it, which will act as germs in promoting the recurrence of the disease. If the tumor be of moderate size, the first incision should be made sufficiently free to allow removal of the whole mass; in the case, however, of a very large tumor, it is well to expose only a portion of it at first, enlarging the wound at a later stage of the operation when necessary; the loss of blood will thus be less than if the whole incision had been made at the beginning.

Fig. 235.



If, when a tumor is exposed, it be found that its deep attachments cannot be safely interfered with, the best thing left for the surgeon to do is to strangulate the base of the growth with strong ligatures, and cut off the remainder: no operation, however, should be undertaken, unless it appear that the whole tumor can be safely extirpated.

After the excision of a tumor, the surgeon should carefully explore with his finger the whole surface of the wound, so as to make sure that no portion of the growth has been allowed to remain: this is particularly important in dealing with a malignant tumor, and, in such a case, any suspicious structures that cannot be removed, may be touched with the actual cautery, or with a solution of chloride of zinc. The lips of the wound may then be approximated with a few points of suture and adhesive strips, and lightly dressed with a strip of lint dipped in olive oil, or any other simple application that may seem appropriate. If the cavity left by the removal of the tumor be large, a drainage tube may be introduced, and the part should be supported with a compress and bandage, to prevent oozing or accumulation of pus.

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[1] Roncière advises that the cellular tissue around a tumor should be blown up with air to facilitate its excision.

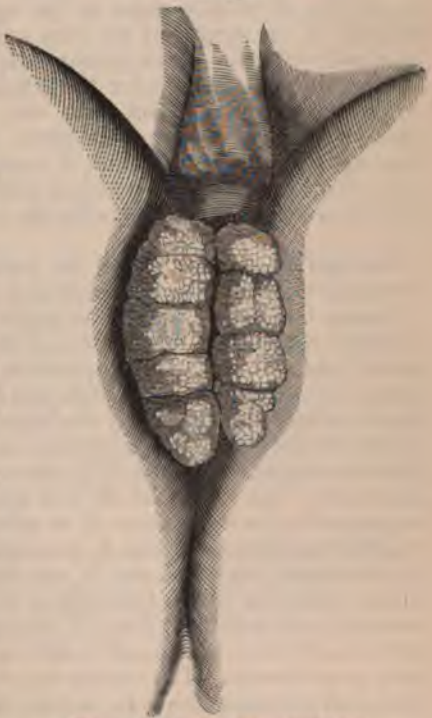
CHAPTER XXVII.

SURGICAL DISEASES OF THE SKIN, AREOLAR TISSUE, LYMPHATICS, MUSCLES, TENDONS, AND BURSÆ.

DISEASES OF THE SKIN AND ITS APPENDAGES.

THE consideration of the ordinary cutaneous affections, which are commonly spoken of as "*skin diseases*," does not properly come within the scope of this work; but there are certain morbid conditions of the skin and its appendages which require surgical manipulations in their treatment, and which may, therefore, be here appropriately referred to.

FIG. 236.



Warts around the anus. (ASHTON.)

Verrucæ or Warts.—Warts consist of hypertrophied cutaneous papillæ, which may project, each papilla by itself, or, as is more usual, ensheathed by a common investment of thickened scaly epithelium. They occasionally attain a considerable size, constituting some of the so-called *horns* met with in various parts of the body. Anatomically, they belong to the *papillary* variety of tumor. The simple warts which appear upon the hands and face come without any apparent cause, and often disappear spontaneously. In other cases, they remain permanently, becoming of a dark color, and occasionally forming a nidus for epitheliomatous formations, as do sometimes the analogous growths known as *moles*. The treatment consists in the application of nitrate of silver in substance, nitric or chromic acid, or the muriated tincture of iron—or in ligation or excision, if the wart be pedunculated. Warts occasionally have a moist, muco-cutaneous covering, and are irritable and disposed to bleed; the glycerate of tannic acid will often be found a useful application in this form of the disease. Warts not unfrequently occur upon the muco-cutaneous surfaces of the anus, or of the genital organs in either sex, and in the latter situation are often spoken of as *venereal warts* or *vegetations:* they are not, however, necessarily of a venereal origin, but may be produced simply by the irritation of frequent sexual intercourse, or may even result from the accumulation of smegma and want of personal cleanliness. They are particularly apt to occur in persons with congenital phimosis. The *treatment* consists in the application of nitric or chromic acid, or powdered calomel, or in paring or snipping off the growths with a sharp knife or scissors, and cauterizing the surface from which they spring. Warts of the generative organs, and occasionally those of the hand, appear to be communicable by contact.

Corns are local indurations and hypertrophies, usually confined to the *cuticle*, but occasionally involving the *papillæ of the true skin.* Corns result from intermittent pressure, as from wearing badly-fitting boots, and are chiefly seen on the feet, but occasionally on the hands, knees, elbows, and, according to Hulke, even on the tongue. *Hard Corns* are such as form upon exposed surfaces, as on the edge of the foot, and are consequently dry and indurated, while *Soft Corns* are such as occur in situations where they are kept moist, as between the toes, where they assume a spongy, mucous appearance, not unlike the *mucous patch* of syphilis. *Bursæ* are occasionally developed beneath both varieties of the affection. Soft corns are usually more irritable than the hard, but either may be very painful if inflamed, the *Papillary Corn,* which occurs principally on the sole of the foot, causing, probably, more acute suffering than any other variety.

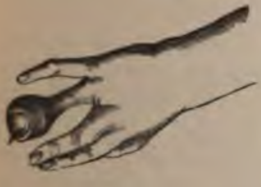
The *treatment of hard corns* consists in relieving the part from pressure by the use of suitable shoes or the application of a perforated plaster, in shaving off the surface of the corn and applying the solid stick of nitrate of silver to its base, or in excising the centre of the indurated part with a sharp knife or scissors, after the whole has been softened by the use of a warm water-dressing. *Soft corns* may be dusted with powdered oxide of zinc, or touched with nitrate of silver or glacial acetic acid, the toes being kept apart by the interposition of scraped lint or raw cotton. Suppuration occurring beneath a corn requires poulticing and the evacuation of the pus after shaving down the part with the point of a sharp lancet.

Onychia is an affection of the matrix of the nails, of which we may recognize two varieties, the *simple* and the *malignant.*

Simple Onychia, or, as it is vulgarly called, "*run-around,*" consists in an inflamed condition of the matrix of the nail, usually resulting from slight injury, and attended with suppuration and loosening of the nail, which becomes shrivelled and discolored, and is eventually cast off—the new nail which forms being commonly thickened and distorted. This affection occurs chiefly in the hand, and is almost exclusively confined to children. The *treatment* consists in the use of poultices, or water-dressing, until the nail has separated. The growth of the new nail may sometimes be advantageously regulated by the application of an adhesive strip or a layer of wax.

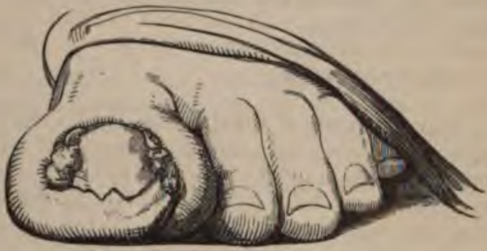
Malignant Onychia results from injuries occurring to persons in a depressed constitutional condition, and is usually seen in the thumb or forefinger, or in the great toe, where it sometimes receives the name of *toe-nail ulcer.* It consists in an unhealthy form of ulceration in the matrix of the nail, which becomes brown or black, and is thrown off, its place being occupied by fungous granulations. The disease has little or no tendency to a spontaneous cure, and sometimes leads to necrosis of the ungual phalanx. The *treatment* may consist in avulsion of any portion of the nail which remains, and thorough cauterization of the matrix with solid nitrate of silver—a simple dressing, such as lime-water, being afterwards applied, while the parts are kept well supported with strips of adhesive plaster; or, which I think better, in simply trimming the nail to the level of the ulcer, and then applying powdered nitrate of lead, as advised by Moerloose, Vanzetti, and MacCormac; the nitrate forms a thick crust, which separates after several days, leaving a healed, or rapidly healing, surface; the application gives rise to severe pain, which lasts for several hours, but the treatment is prompt and efficient, and has the great advantage of allowing the preservation of the nail. Other plans are recommended by various authors: T. Smith, following Abernethy, advises the application of dilute Fowler's solution, while Vanzetti recommends the employment of powdered quicklime, and Babacci the application of charcoal and camphor. *Syphilitic Onychia* has already been referred to at page 459; it requires the application of black or yellow wash, with the use of suitable antisyphilitic remedies. *Amputation* may be required, if necrosis occur in a neglected case of onychia maligna.

FIG. 237.



Malignant onychia. (DRUITT.)

FIG. 238.



Toe-nail ulcer. (LISTON.)

Ingrowing Toe-Nail is an affection almost exclusively confined to the outer side of the great toe; it results from wearing narrow shoes, which compress the foot and cause the soft part of the toe to overlap its nail, giving rise to an ulcer which is painful and persistent. A cure may be sometimes effected by dusting the ulcer with oxide of zinc, or interposing a little lint, or a strip of adhesive plaster, between the nail and the inflamed part of the toe; but in many cases it will be necessary to remove a portion, or the whole, of the nail. This may be done (the patient being etherized) by thrusting one blade of a pair of sharp-pointed scissors beneath the nail up to its root, when the whole nail may be divided at a single stroke; the segment to be removed is then grasped with forceps, and torn away from the matrix, this process being repeated on the other side, if necessary, and the part then simply dressed with wet lint. A new nail grows, which is usually straight and well formed. The shoe must, of course, be so arranged as to free the part from pressure.

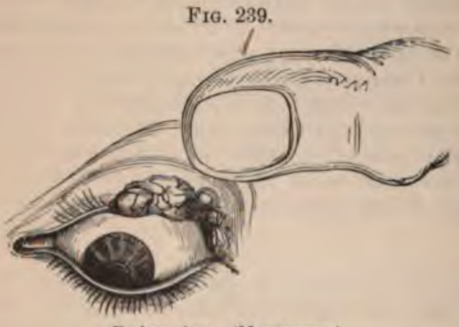
Hypertrophy of a Toe-Nail, usually of that of the great toe, is occasionally met with, the laminæ of the nail becoming distorted, and constituting a horn-like protuberance which may grow so large as to interfere with walking. The *treatment* consists in avulsion of the nail, which operation usually effects a permanent cure.

Keloid or Cheloid (**of Alibert**) is an affection met with chiefly, if not exclusively, in the scars produced by burns or by wounds, and especially in those produced by flogging, and is to be distinguished from the disease known as **Morphæa** or the **Keloid of Addison** (*true keloid*), which occurs in healthy skins, where it produces a scar-like appearance. The former appears in the shape of small and shining, indurated elevations, of a dusky red color, which extend, sending out, as it were, claw-like processes, and are attended during their growth by great itching and considerable pain. In their structure they correspond with the *fibro-cellular outgrowths* described in the last chapter. The *Keloid of Addison* begins as a "white patch or opacity" of the skin, surrounded by a zone of redness, gradually spreading and inducing contraction of fasciæ and tendons, and giving a "hide-bound" character to the part affected.[1] The *treatment* of either form of keloid is very unsatisfactory. Extirpation with the knife has been tried, but the disease almost invariably recurs. Dr. Addison derived advantage from the use of iodine, both internally and externally, in one case of the variety of the disease known by his name.

Warty Tumors of Cicatrices.—Under the name of *Warty Tumor* or *Warty Ulcer of Cicatrices*, an affection somewhat resembling the keloid of Alibert has been described by Cæsar Hawkins.[2] Some of these warty ulcers are non-malignant, being of a fibro-cellular character, but others are really epitheliomata of a papillary form. When occurring over the anterior surface of the tibia, as in the so-called "*Warty Ulcer of Marjolin*," they are very often complicated by a carious condition of the bone. The *treatment* consists in excision or amputation, according to the size and locality of the affection; the operation, even when the disease is epitheliomatous, often resulting in an apparently permanent cure. Recovery may, according to Collis, be sometimes obtained in the early stage by the application of bismuth, or of ice.

Rodent Ulcer. — This affection, which is also known as *Jacob's*[3] *Ulcer*, is most often seen in the eyelids, cheeks, upper lip, nose, or scalp, but may also occur in other parts of the body. It is a disease of late adult life, and commonly originates in some tubercle or mole, which may have existed for many years. It is usually single, at first rounded, but becoming irregular as it spreads, with indurated base and edge, and a somewhat abrupt, and but slightly elevated border; it very rarely assumes the character of a tumor. The ulcerated surface is smooth, glossy, and dry, and of a reddish-yellow color. The progress of the disease, though extremely indolent and chronic, is never spontaneously arrested, though partial cicatrization may sometimes occur. The rodent ulcer produces frightful ravages, exposing the orbit, nasal cavities, pharynx, or even the brain, and thus ultimately causing death—though the local character of the affection is strictly maintained to the last, the lymphatics and distant organs never becoming involved. The microscopic characters of the rodent ulcer are, according to Paget, Hutchinson, and Golding-Bird, simply those observed in ordinary granula-

FIG. 239.



Rodent ulcer. (MACKENZIE.)

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[1] Addison, in *Med.-Chir. Transactions*, vol. xxxvii. pp. 27–47. According to J. Collins Warren, of Boston, the two forms of keloid cannot be distinguished by their anatomical features.

[2] Med.-Chir. Trans., vol. xix. pp. 19–34.

[3] See Dr. Jacob's paper in *Dublin Hosp. Reports*, vol. iv. pp. 232–239.

tions; Collis classes the disease among myeloid or fibro-plastic growths, while, on the other hand, Billroth, with Moore and J. Collins Warren, who have each written excellent monographs upon the subject, look upon it as a form of cancer. The *treatment* consists in complete extirpation, which is best accomplished, when possible, with the knife. If, however, excision be contra-indicated by the size or locality of the ulcer, or the age of the patient, caustics may be employed, the Vienna or Canquoin's paste, or nitric acid, or acid nitrate of mercury, being respectively preferred, according to the deep or superficial character of the affection.

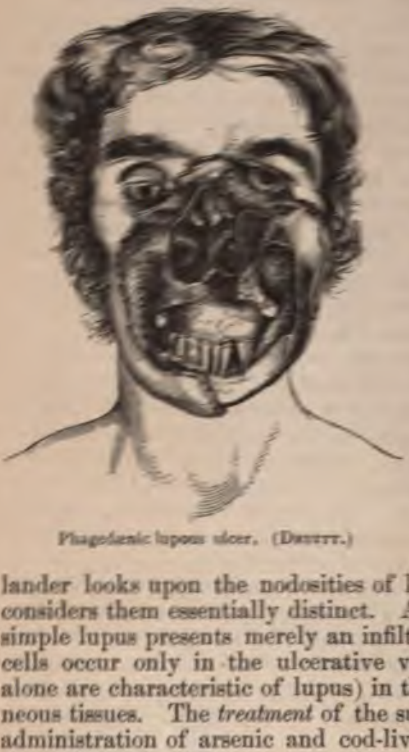
Perforating Ulcer of the Foot.—This is a curious affection which appears to be less common in this country than in Europe. I have, however, seen two cases of the disease, corresponding in every particular with the descriptions given by Hancock, Duplay, and other writers on the subject. The affection consists in an intractable form of ulceration, usually occupying the anterior part of the sole of the foot, and leading to destructive disorganization of the neighboring bones and joints. It often begins as a bunion, appearing to result from undue pressure on the part, or as the result of exposure to cold, when it may be mistaken for ordinary frost bite. Poncet and Estlander regard it as analogous to the anæsthetic form of elephantiasis (*Lepra anæsthetica*), but Duplay and Morat, from dissection of numerous specimens and careful study of the literature of the affection, conclude that the disease originates in degenerative lesions of the nerves of the part, from traumatic or other causes. Fischer, of Breslau, and Savory and Butlin, adopt a similar theory, and the former describes the disease as a malignant form of neuro-paralytic ulceration, but a more recent autopsy recorded by Michaux has failed to confirm this view. Ball and Thibierge have seen perforating ulcers in connection with locomotor ataxia. Englisch points out, from a study of 109 cases, that the localization of the disease corresponds with the position of the bursæ mucosæ of the sole, and concludes that it is caused by a vascular change analogous to the endoarteritis obliterans or proliferans of Friedlander and Billroth. Perforating ulcer has been not unfrequently confounded with the *Mycetoma*, or fungus disease of India (tubercular disease of the foot, of Hancock). The *treatment* consists in removing the diseased bone by gouging, excision, or, if necessary, amputation, and in endeavoring to improve the nutrition of the limb by the use of galvanism, frictions, etc. If the cause of the nervous or vascular changes in which the disease originates can be discovered, an attempt should of course be made to remedy the evil so as to prevent a recurrence of the affection. Dubrueil describes, under the name of "dorsal disease of the toes," an inflamed or ulcerated condition of adventitious bursæ which are formed on the back of the toes under the influence of pressure. Després has described a case of perforating ulcer of the *hand*.

Lupus.—Under this name are commonly included two affections, which may be described as *Lupus Non-exedens*, or *Simple Lupus*, and *Lupus Exedens*, or *Ulcerating Lupus*.

Lupus Non-exedens appears as a red patch on the skin (usually of the face), attended with brawny desquamation, and sometimes accompanied with indolent tubercles. It runs a very chronic course, and produces inconvenience merely by the deformity and scar-like contraction to which it gives rise. It is usually seen in persons of a scrofulous diathesis. The *treatment* consists in the administration of tonics, especially of cod-liver oil, with arsenic, and in the local use of a solution of nitrate of silver, gr. x–xx to f℥j.

Lupus Exedens, *Ulcerated Lupus*, or *Lupous Ulcer*, is usually seated on the tip or alæ of the nose, but sometimes on the upper lip, or in other situations, and is chiefly seen in young persons. It begins as one or more reddish papules, or tubercles, which soon ulcerate and coalesce. The lupous ulcer may be *superficial*, when it appears as a fungous, warty, ulcerated surface, with prominent nodular granulations, which are often scabbed over by the drying of the discharge, and are sometimes irritable, though seldom disposed to bleed. The ulceration progresses under the scabs, and the affection is liable, at any moment, to assume the *deep* or *phagedænic* form, which was known to the older writers as noli-me-tangere. The phagedænic lupous ulcer is a very painful affection, attended with great destruction of tissue, and accompanied with a fetid discharge. Under its influence, the greater part of the nose may melt away, as it were, in the course of a few weeks, and it is to be observed that, when the ulcer has reached the level of the rest of the face, it may become at least temporarily arrested. The affection rarely proves fatal by itself, and cicatrization may occur, adding to the deformity caused by the disease, by inducing contraction and distortion of neighboring parts. The *microscopic appearances* of lupus have been investigated by several pathologists, among whom Essig finds that the corium is infiltrated with round cells which in some specimens follow the track of the vessels and arrange themselves in heaps around them; spindle-shaped and giant cells are also found in some cases. According to Thoma and Thin, the cell-infiltration originates in exuded white corpuscles. Lang believes the giant cells to represent an intermediate stage in the process of degeneration of the tissues. Friedlander looks upon the nodosities of lupus as true tubercles, but Colomiatti considers them essentially distinct. According to Piffard, the superficial or simple lupus presents merely an infiltration of round cells, while the giant cells occur only in the ulcerative variety, and the "cell-heaps" (which alone are characteristic of lupus) in those cases which involve the subcutaneous tissues. The *treatment* of the superficial form of lupus consists in the administration of arsenic and cod-liver oil, and in the local use of a solution of nitrate of silver, diluted tincture of iodine, or dilute citrine ointment. Riehl advises the employment, for from half a minute to two minutes, of a solution of caustic potassa (one part to two), followed by applications of finely powdered iodoform. The phagedænic variety of lupus requires the application of caustics, or of the actual or electric cautery, together with the constitutional treatment already recommended. Volkmann employs *erasion*, or scraping away the diseased tissue with a sharp spoon or scoop, and Hutchinson prefers this mode of treatment to any other; Dr. Piffard and Mr. Godlee also employ erasion, but the former supplements it with the actual cautery, and the latter, after checking the hemorrhage by pressure with lint, applies an ointment of iodoform and oil of eucalyptus. Squire recommends linear scarification, as in cases of "port-wine stain."

FIG. 280.



Phagedænic lupous ulcer. (DRUITT.)

(See Chap. XXIX.) Excision may be resorted to in certain situations, as the upper lip or nose, the resulting gap being closed by a plastic operation, if necessary. Lupus, complicated with a syphilitic taint, requires the administration of the iodide of potassium.

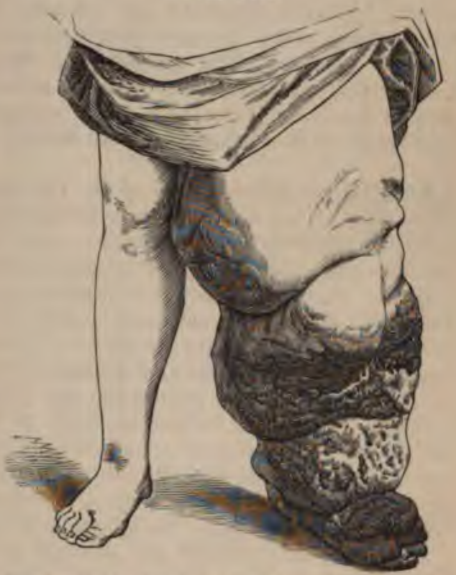
Malignant Diseases of the Skin.—Both cancer and epithelioma may occur primarily in the skin, as was mentioned in speaking of those affections. The treatment consists in excision, or amputation, according to the size and situation of the malignant growth.

DISEASES OF THE AREOLAR TISSUE.

Cellulitis, or *Inflammation of the Areolar Tissue* may be *circumscribed* or *diffused:* in the former case it gives rise to an *abscess*, and in the latter to *diffused suppuration*. When depending upon an erysipelatous taint, it constitutes *cellular erysipelas* (see pp. 394, 409).

Elephantiasis Arabum, or Arabian Elephantiasis, may be described as a hypertrophy of the skin and subcutaneous areolar tissue. In its structure it corresponds with the *fibro-cellular outgrowths* described in Chapter XXVI. It is chiefly seen in the scrotum, and in the lower extremity, where it constitutes the affection known as Barbadoes leg. Its appearances are well shown in the annexed cut (Fig. 241), from a paper by Dr. Isaac Smith, Jr., of Fall River, Mass. This form of elephantiasis is closely analogous to the affections known by modern pathologists as *Sclerema* or *Scleroderma*, as well as to that described by Mott and Stokes as *Pachydermatocele*, the *Eiloides* of Warren, the *Dermatolysis* of Wilson, and the *Molluscum fibrosum* of Pollock and Ford. The *treatment* consists in the use of pressure, ligation of the main artery of the part, excision, or amputation, according to the circumstances of the particular case (see page 480).

FIG. 241.



Elephantiasis Arabum in the lower extremity; Barbadoes leg. (SMITH.)

DISEASES OF THE LYMPHATIC SYSTEM.

Angeioleucitis or Lymphangeitis (*Inflammation of the Lymphatic Vessels or Absorbents*) may occur as an idiopathic affection, as a complication of erysipelas, or as the result of the irritation produced by a wound, ulcer, or local inflammation, as in cases of gonorrhœa. Its occurrence is usually preceded or accompanied by marked constitutional disturbance, rigors, and febrile reaction. If the inflamed lymphatics be superficial, their course will be marked by a number of fine lines, which soon coalesce into a band about an inch wide, of a *vivid red color*, running from the point at which the disease originates to or beyond the nearest lymphatic glands, which are always themselves inflamed. The line of the absorbents is somewhat doughy, and not very tender, and the limb is usually swollen and often erythematous. If the inflammation affect only the deep lymphatics, the affection of the glands may alone be perceptible. *Resolution* usually occurs in the course of a week or ten days, though suppuration often takes place in the glands, and sometimes in the lymphatics themselves; the prognosis is favorable, though death may occur from the supervention of erysipelas, pyæmia, or diffuse cellulitis. The only disease with which angeioleucitis is likely to be confounded is *phlebitis*, from which it may be distinguished by observing that the red line in the latter affection has a *dusky hue*, and gives a peculiar cord-like and knotty sensation to the touch. The *local treatment* consists in the application of nitrate of silver along the line of inflamed lymphatics, so as to blacken without blistering the skin; the limb may then be wrapped in carded cotton. Should suppuration threaten, poultices may be employed, and pus evacuated by early incisions. The *constitutional treatment* consists in the use of saline diaphoretics and anodynes, with or without stimulants, according to the general condition of the patient. If erysipelas occur, the tinct. ferri chloridi may be given in combination with the liq. ammonii acetatis.

Adenitis, or *Inflammation of the Lymphatic Glands*, always accompanies angeioleucitis, but may also occur independently, as the result of transmitted irritation (as in sympathetic bubo), or of the absorption of morbid matter (as after poisoned wounds, or in chancroidal bubo), or as the result of direct violence, or of over-exertion in walking or otherwise. The so-called *bubon d'emblée* is, as already mentioned (p. 447), an instance of this form of adenitis. The symptoms of adenitis are those of circumscribed, deep-seated inflammation in general, terminating sometimes in resolution, but more often in suppuration, or in chronic induration and hypertrophy. The *treatment* consists in the use of blisters, nitrate of silver, or tincture of iodine, applied around but not over the inflamed gland, with poultices and early incisions if suppuration ensue, together with the administration of anodyne diaphoretics during the acute stage, and tonics, such as cod-liver oil and iron, especially in the form of the iodide, when the affection assumes a chronic form.

The lymphatic glands are affected in *Tuberculosis*, in *Scrofula*, and in *Syphilis*, and are frequently the seat of various morbid growths, particularly the *adenoid*, and those of a *malignant* nature. The *treatment* appropriate to these various conditions has already been described in the chapters on the several affections referred to.

Varicose Lymphatics; Lymphangeiomata.—A dilated or varicose condition of the lymphatic vessels has been occasionally met with, and may form a troublesome complication in cases of Arabian Elephantiasis, when, according to Manson, the lymphatic fluid contains filariæ. By spontaneous rupture, or accidental wound, a fistulous opening may be formed, through which the lymphatic fluid escapes, constituting the disease known as *Lymphorrhœa*. The *treatment* consists in the application of caustic, and in the use of pressure.

DISEASES OF MUSCLES AND TENDONS.

Myositis, or *Inflammation of the muscular tissue*, may occur as a *primary* affection, as the result of injury, etc., or may be *secondary*, depending upon various lesions of other structures, especially of the bones and joints. Its *symptoms* and *treatment* have already been sufficiently considered in the chapters on Inflammation in general.

Fatty Degeneration of muscle is a not infrequent sequence of inflammation of the muscular tissue, conjoined with long disuse, and may probably in some cases be dependent on the latter cause alone. In some cases, to which the name of *interstitial fatty degeneration* has been given, the striated character of the muscular fibre is still preserved, the connecting tissue alone being replaced by oily matter; in other cases the change is more complete, the whole muscle being converted into a fatty and granular mass (*necrobiotic or intrinsic fatty degeneration*). The latter condition appears to depend upon more complete disuse of the muscle than the interstitial form, and is probably incurable. The *treatment* of the milder cases consists in endeavoring to restore, or at least maintain, the nutrition of the part, by passive exercise, frictions, etc.

Rigid Contraction of Muscles.—Another consequence of muscular inflammation, especially in persons of a gouty or rheumatic tendency, is rigid contraction of the affected muscle, giving rise to deformity, and often attended with much pain. This is most often seen in the sterno-cleido-mastoid and splenius muscles, the rigid contraction of which causes the affection known as *stiff* or *wry-neck*. The pelvic muscles also often become contracted as a consequence of hip disease. Rigid muscular contraction may likewise result from mere disuse, from long-continued spasm, and from paralysis of opposing muscles. Examples of the two latter conditions are seen in cases of club-foot. When rigid contraction persists for a long time, it is accompanied by *atrophy* and usually by *fatty degeneration* of the muscular tissue.

The *treatment* of the inflammatory form of the affection consists in the use of stimulating embrocations, and the administration of anodynes, colchicum, iodide of potassium, etc.; while the more permanent cases require the use of elastic extension, or division of the contracted muscle or its tendon. (See *Orthopædic Surgery*.) Ricord and others have described a peculiar form of muscular contraction which is dependent upon *syphilis;* it is chiefly seen in the biceps, and yields readily to the administration of iodide of potassium.

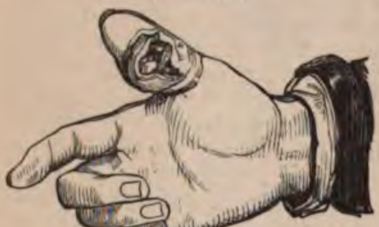
Ossification of Muscle is a rare affection, of which cases have been recorded by Abernethy and Hawkins, and which apparently depends on the coincidence of muscular inflammation with a tendency to excessive bony deposit. Münchmeyer gives this affection the name of *progressive ossifying myositis;* but, according to Mays, the ossific change begins, not in the muscle itself, but in the intermuscular connective tissue. It is usually accompanied by the development of numerous exostoses, as in a remarkable case recorded by Dr. Hutchinson, of this city. The *treatment* consists in the repeated applica-cation of blisters, with the internal use of colchicum, iodide of potassium, etc.

Tumors in Muscle.—Various forms of tumor occur in muscular tissue, the most important being of the cancerous, fibrous, cystic, and vascular varieties. Cartilaginous and osseous tumors are also met with, but are comparatively rare. *Hydatids* are occasionally found in muscle. The *treatment* of these various affections is to be conducted on ordinary surgical principles. Excision usually presents no particular difficulties, and, except in the cases of malignant tumor, may be expected to effect a permanent cure. For the cancerous tumors, unless the case be seen at a very early period, amputation (if the tumor be suitably situated) offers a better chance than excision, and should in most instances be preferred. If, however, the case be seen at a very early stage, an attempt should be made to preserve the limb, by extirpating the tumor with a wide margin of healthy tissue. If practicable, the plan suggested by Teevan might be adopted, of dissecting out the entire muscle in which the malignant growth was seated.

Tenosynovitis, or *Inflammation of Tendons and their Sheaths or Thecæ* (*Thecitis*), occurs as the result of injury, as well as in cases of gout or rheumatism. This disease, which has been well studied by Hopkins, is characterized by the appearance of a tender, puffy swelling in the course of the affected tendon, with a peculiar sensation of *fine crackling* or *dry crepitation*, best marked when the disease has become chronic. The *treatment* consists in rest, with the use of iodine, stimulating embrocations, or blisters.

Paronychia or Whitlow (*Panaris*) consists in inflammation of the flexor tendons and sheaths of the fingers. In the mildest form of the disease, the theca is but slightly, if at all, involved, the inflammation being chiefly confined to the dense subcutaneous tissue of the pulp of the finger, being, in fact, a mere digital abscess. In the true paronychia, or *tendinous whitlow*, the theca is principally affected, suppuration often extending in the course of the tendon beneath the palmar fascia (giving rise to *palmar abscess*), or even to the forearm, involving, perhaps, the remaining fingers, and causing extensive destruction of parts by sloughing. In the worst form of the disease, or *felon*, the phalangeal periosteum is involved, often leading to necrosis and exfoliation of considerable portions of bone, with destruction of neighboring articulations. The disease commonly originates from some slight puncture or other injury to the extremity of the finger, and is usually, though not invariably, confined to the palmar surface. Paronychia occasionally occurs as an epidemic, without being traceable to any traumatic cause, and is believed by Erichsen to be uniformly of an erysipelatous nature. The symptoms are those of deep-seated inflammation, with intense throbbing pain and tenderness, much aggravated by the depending position, and with considerable constitutional disturbance. Though suppuration may occur pretty early in the disease, fluctuation is not very apparent, on account of the density of the intervening tissues. Gangrene is occasionally, but rarely, met with.

Fig 242.



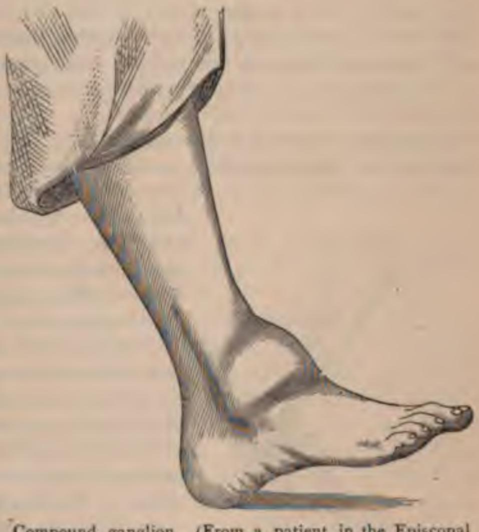
Felon. (Liston.)

The *treatment* consists in the application of leeches, followed by poultices, or by soaking the hand in water as hot as can be borne, together with the internal administration of laxatives and anodyne diaphoretics. If relief do not follow in the course of twenty-four hours, a deep incision should be made on one or both sides of the affected phalanx, so as to relieve tension and evacuate any pus that may be present. The incision should not be made in the *centre* of the finger, lest the sheath be opened, when the tendon would almost certainly slough; nor too far towards the side, lest the digital artery be wounded. The incision should be made from above downwards, so that, if the patient withdraw his hand suddenly, he may rather assist than hinder the completion of the operation. If suppuration extend along the sheath of the tendon towards the palm, the surgeon must follow it up with free incisions, repeated as often as necessary. The strength of the patient must be, at the same time, sustained by the administration of tonics, concentrated food, and stimulus. If necrosis occur, the sequestra must be extracted as soon as they are loosened—partial or complete amputation of a finger being occasionally required, though excision of the phalangeal articulations may sometimes be advantageously substituted. By unremitting care and attention on the part of the surgeon, a hand may often be preserved which will prove quite useful, though somewhat stiff and deformed; but occasionally the destructive process continues in spite of treatment, involving the wrist, and eventually requiring removal of the limb. During the whole after-treatment of a whitlow the hand should be supported on a broad splint, to keep the parts at rest and prevent contraction of the fingers.

Some surgeons endeavor to *abort* whitlow by the application of blisters, tincture of iodine, spirit of camphor, or nitrate of silver; the plan may occasionally succeed, but, if it fail, cannot but aggravate the affection.

Ganglion.—A ganglion is a synovial cyst, developed in connection with the sheath of a tendon. Erichsen distinguishes two varieties, the simple ganglion, which is found *on* the tendinous sheath, and the compound ganglion, which consists of a dilatation of the sheath itself, and which often involves several adjacent tendons. Ganglia vary in size from a third of an inch to two or more inches in diameter, that of the simple ganglion rarely exceeding three-fourths of an inch. Their shape is round or oval, and they contain a clear fluid, varying in consistence from that of serum to that of honey, mingled sometimes with irregularly-shaped melon-seed-like bodies, which have been recently studied by Beatson; these are formed of a compact, fibrinous substance, and appear to have originated from floating masses of fibrin, due to previous inflammation, or to have become separated from the lining wall of the sheath, which is itself often fringed and vascular. Ganglia occur chiefly in connection with the extensor tendons on the back of the hand or wrist, or on the dorsum of the foot, though they are also seen in the palm, extending beneath the annular ligament, or on the side or sole of the foot. They occasion, in some cases, a good deal of pain by pressing on adjacent nerves, and sometimes interfere considerably with the motion of the tendons on which they are seated. The presence of the melon-seed-like bodies may be recognized by the occurrence of a peculiar grating or creaking sound on manipulation. The *treatment* of the smaller ganglia may consist in rupture by forcible compression with the thumbs, or by a sudden

FIG. 243.



Compound ganglion. (From a patient in the Episcopal Hospital.)

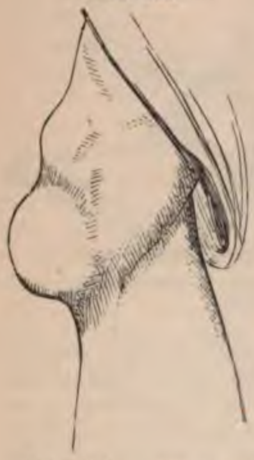
blow, as with a book; or in puncture, and subsequent compression. If these means fail, the interior of the cyst may be scarified, after puncture, with the point of a knife; or iodine may be injected; or a seton established. Excision is attended with some risk—diffuse inflammation occasionally ensuing—and should therefore be employed with hesitation. For the larger ganglia, and especially those beneath the annular ligament of the wrist, repeated blisters may be employed, in hope of inducing consolidation; or recourse may be had to iodine injection, or to the seton. Division of the annular ligament was recommended by Prof. Syme, and has been successfully resorted to by Dr. Copeland, of Virginia. If suppuration occur, the cyst must be opened, the melon-seed-like bodies evacuated, if there be any present, and the wound allowed to heal by granulation. Excision may be required if the ganglion be of large size and with semi-solid contents.

DISEASES OF BURSÆ.

Synovial bursæ exist normally in certain situations, and may be adventitiously developed by continued friction or pressure in other localities. The most important bursæ, in a surgical point of view, are that between the hyoid bone and thyroid cartilage, and those over the acromion, the condyles of the humerus, the olecranon, the styloid processes of the radius and ulna, the tuber ischii, the trochanter major, the anterior superior spinous process of the ilium, the patella, the femoral condyles, the tuberosity of the tibia, the malleoli, the heel, and the heads of the first and last metatarsal bones. Bursæ are also met with beneath the deltoid and gluteus maximus, between the point of the scapula and the edge of the latissimus dorsi, and in the popliteal space.

Bursitis, or *Acute Inflammation of a Synovial Bursa*, is most frequently seen in the *bursa patellæ*, constituting a variety of the disease ordinarily known as "*Housemaid's Knee*," from the fact that women who constantly kneel in scrubbing are peculiarly exposed to the affection. Similarly the enlargement of the bursa over the *olecranon* is known as "*Miner's Elbow*." Acute inflammation of a bursa is attended with much pain and considerable constitutional disturbance. The swelling is superficial, and in the case of the bursa patellæ *above the bone*—a diagnostic point of some importance, as in inflammation of the joint the patella is floated up by the articular effusion. The *treatment* consists in the enforcement of rest, with the application of a suitable splint, a few leeches perhaps, evaporating lotions—or poultices and warm fomentations, if more agreeable to the patient—together with the administration of anodyne and sedative diaphoretics. If *suppuration* occur, a free and early opening must be made, and the case treated as one of abscess. If the incision be delayed, the pus may diffuse itself somewhat widely around the part, necessitating numerous counter-openings. *Caries of the patella* is an occasional sequence of housemaid's knee, requiring the use of the gouge to remove the diseased bone. *Sloughing of the bursa* may likewise sometimes occur, leaving a large ulcer which slowly heals by granulation.

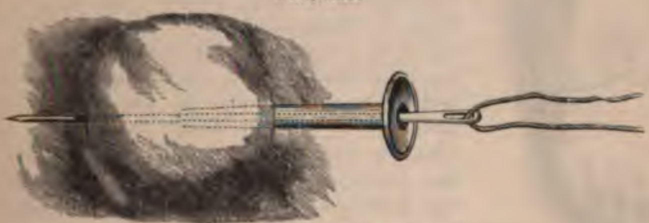
FIG. 244.



Enlarged bursa over the patella, the result of pressure; housemaid's knee. (LISTON.)

Simple Enlargement or Dropsy of a Bursa (Hygroma) may result from subacute inflammation, or simply from long-continued pressure. This condition in the bursa patellæ constitutes the true housemaid's knee, and sometimes causes considerable inconvenience by the bulk of the swelling. The fluid in these enlarged bursæ may be of the ordinary synovial character, or may be of a darker hue, containing cholestearine and disintegrated blood, when it is not unfrequently mixed with numerous rice-like or melon-seed-shaped bodies such as have been described as occurring in compound ganglia, and which appear to consist of imperfectly developed connective tissue, formed originally upon the lining wall of the bursa, and subsequently separated by the friction and constant motion to which the part is subjected.

FIG. 245.



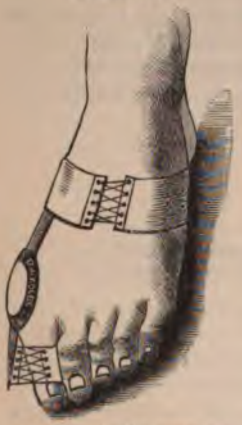
Formation of seton with trocar and canula. (ERICHSEN.)

Virchow and others have observed intra-bursal *bands*, attached by both ends to the wall of the tumor. The *treatment* consists in the application of discutients, such as iodine or blisters; or in tapping, followed by the injection of iodine; or by the establishment of a seton — the thread being passed through the canula as in Fig. 245. If the bursa contains the rice-like bodies above referred to, they must be evacuated through a tolerably free incision, when the seton may be passed as before.

Solid Enlargement of a Bursa is caused by the gradual deposit of organized lymph in the interior of the sac, previously filled with fluid, until the whole or nearly the whole of the cavity is obliterated. A bursa, when cut open under these circumstances, presents a laminated appearance, such as is seen in a partially consolidated aneurism. In some cases, according to Erichsen, the tumor is solid from the first, fibroid matter being primarily deposited in the bursa. The *treatment* consists in the use of sorbefacient remedies, or, if these fail, in excision—taking care not to injure any neighboring articulation, and, in the case of the bursa patellæ, not to open the deep fascia which is attached to that bone, lest the structures of the ham should become involved in suppuration. Annandale has recorded a remarkable case of *bony tumor* occupying the situation of the bursa patellæ.

Bunion.—The term *bunion* is applied to an enlarged bursa occurring in any part of the foot, the most usual seat of the affection being at the side of, or below, the metatarsal joint of the great toe. Bunions appear to be caused by distortion of the foot from wearing narrow-soled and high-heeled shoes, by which the weight of the body is thrown forwards, while the toes are crowded together. The distortion consists in the great toe being thrust outwards, by which means its metatarsal joint becomes prominent—a large corn usually forming over the projection, and either the normal bursa of the part, or one adventitiously developed, becoming enlarged and painful. The bunion is liable to repeated attacks of inflammation, and suppuration may occur, leading perhaps to the formation of a fistulous ulcer, accompanied by a carious condition of the bone and disorganization of the joint, constituting a form of the "perforating ulcer of the foot" of French writers. (See p. 515.) The *treatment* consists in the use of poultices or fomentations, followed by the application of nitrate of silver, to subdue inflammation, together with means adapted to restore the toe to its proper place. This may be best accomplished by the use of Bigg's apparatus (the action of which may be seen from Fig. 246); or, in more severe cases, by dividing subcutaneously the external lateral ligament of the metatarso-phalangeal joint, or the tendons of the adductor or flexor brevis pollicis. In mild cases, it may be sufficient to protect the part by the application of two or three thicknesses of soap plaster, cut into a horseshoe form, as recommended by Brodie, and by the adaptation of a loose and well-fitting shoe. If the bunion contains fluid, and is uninflamed, attempts to promote absorption may be made by applying an ointment of the red iodide of mercury (gr. x–℥j), which is highly recommended by T. Smith. If this fail, subcutaneous puncture and discission of the sac, followed by the external use of iodine, may be tried, and is, according to Gross, as satisfactory as, while it is certainly a safer method than, excision or incision with cauterization. If suppuration occur, the bunion must be opened and treated as an abscess. If caries and articular disorganization follow, amputation through the metatarsal bone may be required, and will, I think, in this position, usually be preferable to excision either of the joint or of the head of the metatarsal bone—though the former operation has been performed with good results by Kramer, Pancoast, and others, and the latter by several surgeons, including Hueter, Hamilton, Gay, of Buffalo, and A. Rose, who recommends the operation even in cases of simple contraction without caries (*hallux valgus*).

FIG. 246.



Apparatus for the treatment of bunion.

CHAPTER XXVIII.

SURGICAL DISEASES OF THE NERVOUS SYSTEM.

THE affections of the nervous system which specially demand attention from the surgeon, are Neuritis, Neuroma, Neuralgia, and Tetanus.

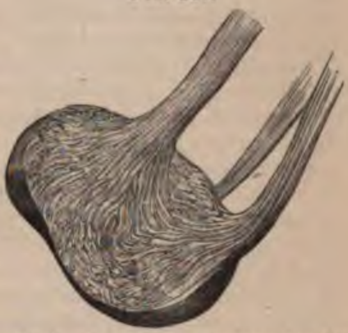
NEURITIS.

Neuritis, or inflammation of a nerve, may occur as a consequence of rheumatism, etc., from exposure to cold, or from wounds or other injuries. The chief symptoms are pain, extending downwards in the course of distribution of the nerve and aggravated by pressure, with general febrile disturbance. The line of the nerve is sometimes reddened and swollen, and there may be spasmodic jerking of the muscles of the part, with various reflex phenomena manifested in other portions of the body. The pathological appearances are swelling and increased vascularity of the neurilemma, with softening of the nerve structure itself. The *treatment*, in the acute stage, consists in the use of local depletion, with the application of ice, or of anodyne and emollient fomentations, as most agreeable to the patient, together with laxatives and diaphoretics, if there be much fever. The affected part should be kept in a state of absolute rest, and hypodermic injections of morphia, with or without atropia, may be employed if the pain is very intense. Colchicum may be used in cases of rheumatic origin, and iodide of potassium, quinia, etc., with counter-irritation, in those of a subacute or chronic character.

NEUROMA.

Neuromata are tumors developed on or between the fasciculi of a nerve. They are usually fibrous tumors, though a few appear to belong to the fibro-cellular variety, a few also containing cysts. Billroth and other modern pathologists divide neuromata into the *true* and *false*, the latter being the fibrous or fibro-cellular growths commonly found in connection with the nerves, while the former, or true neuromata, are "composed entirely of nerve filaments, especially of those with double contours; they appear to come only on nerves, and are very rare." Billroth is disposed to regard the "*amyaline* neuromata" of Virchow as really false neuromata, or, in other words, as fibrous tumors.

FIG. 247.



Section of a neuroma; three nervous trunks terminating in it. The fibrous arrangement shown, as observed by the naked eye. (SMITH.)

Neuromata are almost exclusively confined to the nerves of the cerebro-spinal system,[1] are most common in the male sex, and grow slowly, sometimes attaining a very large size; they are commonly multiple, not less than 1200 sometimes coexisting, according to R. W. Smith, in the same patient. A neuroma is movable transversely, but not longitudinally, on the nerve upon which it is developed. Neuromata may arise spontaneously, or as the result of injury; they may occur in the continuity of a nerve, or at its cut extremity, as is seen in stumps after amputation (see page 107). They are often, but not always, painful, the pain being usually of a paroxysmal character, and sometimes excited only by pressure. In idiopathic neuroma the pain is referred almost exclusively to the peripheral distribution of the nerve, but in traumatic cases is frequently felt in other parts, as a reflex phenomenon. When present in very large numbers, neuromata are, fortunately, usually painless. The *painful subcutaneous tubercle* is believed by many writers to be a "true neuroma" (see page 489). It is advised by Brown-Séquard that, in examining a neuroma, the nerve should be firmly compressed above the tumor, so as to diminish the pain caused by the necessary manipulations. The *treatment* consists in extirpation of the tumor, which should, if possible, be dissected from the nerve without dividing the latter; if this cannot be done, Notta's plan might be followed, and the cut ends of the nerve approximated by means of a suture (see page 209). For the treatment of neuromata in stumps, see page 107. In cases of multiple neuromata, operative interference can seldom be justifiable, but under such circumstances a trial may be given to electro-puncture, or the hypodermic use of morphia may be resorted to as a palliative measure. Prof. Kosinsky, a German surgeon, and Drs. Duhring and Maury, of this city, have, however, reported remarkable cases of multiple painful neuromata of the skin, in which temporary relief was afforded by excision of the nerves of the affected parts.

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[1] The "plexiform neuroma," however (a name given by Verneuil), has been found in the solar plexus.

NEURALGIA.

Neuralgia is an affection of the nervous system, characterized by intense pain of a paroxysmal form, usually referred to the course of particular nerves. Any discussion as to the nature and pathology of neuralgia in general would be out of place in a work such as this, and I shall therefore consider merely those forms of the disease which come particularly under the notice of the surgeon. Neuralgia occurs usually in persons who are debilitated, and is predisposed to by various depressing causes, such as exposure to miasmatic influence, etc. It frequently coexists with hysteria, and not seldom with anæmia. It may be excited by some source of local irritation, as a decayed tooth, piece of necrosed bone, or exostosis, or may be a reflex phenomenon from irritation of another part, as in the toothache of pregnancy. The pain of neuralgia may follow accurately the course and distribution of a nerve, or may be felt over a considerable extent of surface, or in particular organs, such as the breasts, testes, or articulations—as in the cases of so-called "hysterical knee-joint." The pain may begin suddenly, or may come on gradually, and is, in different cases, of every variety of character and intensity; it is always paroxysmal, and often absolutely intermittent, and is uniformly aggravated by the supervention of any additional source of depression. There are almost always tender spots (*points douloureux*) in the course of the affected nerve, particularly where it penetrates a fascia, or emerges from a bony canal, and very constantly there is tenderness over the spinous processes of those vertebræ which correspond to the part of the spinal cord whence the nerve originates. Another peculiarity of neuralgic pain is that it is almost always unilateral. Neuralgia is sometimes accompanied with spasm of the muscles supplied by the affected nerve; in other cases the surface becomes red, hot, and even slightly swollen, and there is often an increased secretion from neighboring glands, as the salivary or lachrymal. Though any part of the body may be affected by neuralgia, its most frequent seats are the branches of the fifth pair of cerebral nerves, and the great sciatic; in the former situation it constitutes the disease known as "*tic douloureux*."

The *diagnosis* is usually sufficiently easy: from inflammatory pain, neuralgia may be distinguished by its paroxysmal character, by the absence of fever, by the superficial nature of the pain (often accompanied with marked cutaneous hyperæsthesia), and by its being relieved rather than aggravated by pressure; if, however, as sometimes happens, neuralgia coexist with deep-seated inflammation, it may be extremely difficult to decide how much of the pain felt is to be attributed to one, and how much to the other affection. In cases of neuralgia affecting the joints, the diagnosis may be assisted by remembering that organic disease cannot long exist in an articulation without causing deformity or other physical alteration. The *prognosis* of neuralgia, as regards life, is usually favorable; the disease, however, is often very intractable, and may cause so much suffering as to render existence almost insupportable.

The *treatment* must be both *general* and *local*. As the disease is almost always accompanied by debility, tonics are usually required: having first cleared out the bowels by means of a cathartic, the surgeon may begin at once the use of quinia, in doses of four grains, three or four times a day; this drug, though particularly serviceable in cases of malarial origin, is adapted to all cases of neuralgia in which the paroxysmal element is marked. Arsenic is another remedy of great value, and may be given in the form of arsenious acid, or of Fowler's solution. Iron is particularly adapted to anæmic cases, and valerianate of zinc and assafœtida to those which are complicated with hysteria. Advantage may often be derived from sea-bathing, or from the systematic employment of electricity, the cold douche, etc. In cases in which there is nocturnal exacerbation, the iodide of potassium is found a valuable remedy. The *local treatment* consists in the application of sedatives or counter-irritants, and, in certain cases, in excision of a portion of the affected nerve. Chloroform and aconite liniments, and the veratria ointment, are among the most useful applications, but the hypodermic injection of morphia is unquestionably the most powerful means we possess for controlling neuralgic pain: from eight to fifteen minims of Magendie's solution may be used at a time, the injection being repeated in the course of three or four hours if the pain is not relieved. Advantage may be sometimes derived from the simultaneous administration, by the hypodermic method, of morphia and atropia. A quarter of a grain of the former with a thirtieth of a grain of the latter may be used, great care being exercised lest a poisonous effect be induced. Chloloform, carbolic acid, and nitrate of silver have also been employed hypodermically with advantage in some cases.

Excision of a Portion of the Affected Nerve has been not unfrequently practised in cases of neuralgia affecting branches of the fifth pair, and occasionally with the happiest results. In many cases, however, the relief has proved but temporary, the pain recurring after an interval of a few weeks or months in the same or another branch. The *Infra-orbital* and *Mental Nerves* may be reached by simply cutting down at their points of exit from the infra-orbital or mental foramina, the nerves being then isolated and a portion excised. Lasalle advises that the infra-orbital nerve should be sought for in the orbital cavity itself. The *Inferior Dental Nerve* may be reached by raising a semilunar flap from over the ramus of the lower jaw, and exposing the dental canal by means of a trephine; the nerve is then picked up with a blunt hook or director, and a portion of it excised. Prof. Gross has, by repeated applications of the trephine, succeeded in exposing and removing the whole extent of the nerve, from its entrance into the inferior dental canal to its exit at the chin—the portions of nerve thus exsected varying in length, in different cases, from two and a half to three inches, and the operation having been apparently followed by the best results. Paravicini, Mosetig-Moorhof, Michel, and Terrillon, recommend an intra-buccal section of the nerve, which, however, appears to me more difficult and less satisfactory than the ordinary mode of procedure. Dr. A. Brown effected a cure in one case by thrusting a hot steel wire into the mental foramen, so as to destroy the nerve. The *buccal branch* of the inferior maxillary nerve has been divided from without by Michel, Letiévant, and Valette, and from within by Nélaton and Panas. The *Superior Maxillary Nerve* may be reached, close to the foramen rotundum, by means of a Y-shaped or simple curved incision, both walls of the antrum being cut away with the trephine, and the lower wall of the infra-orbital canal with cutting-pliers and chisels. The nerve being separated from the other tissues in the spheno-maxillary fossa, and traced beyond the Ganglion of Meckel, is divided from below upwards with blunt-pointed, curved scissors. This bold and severe operation, which was introduced by

Carnochan, of New York, has been at least temporarily successful in several instances; but that the relief is not permanent, would appear from the researches of Conner, of Cincinnati, who has collected thirteen cases, in seven of which the pain is known to have recurred, while in only two of the remainder was the subsequent history of the patient traced for more than a year. Dennis, of New York, however, finds that more or less benefit has been derived from the operation of neurectomy in 16 out of 21 cases in which it has been resorted to.

Neurectomy of the *median*, *musculo-spiral*, *sciatic*, and other nerves of the extremities, has been practised by various surgeons, including Sapolini, Brinton, Morton, Hodge, Golding-Bird, and myself, with at least temporary benefit.

If the neuralgia arise from peripheral irritation, so that the affected portion of the nerve can be removed, an operation such as those which have been described, may probably suffice for a cure; if, however, the disease be of central origin, it is obvious that no operation can be of permanent benefit. When neurectomy is in any case resorted to, at least two inches of the affected nerve should, if possible, be removed, and care should be taken that the upper section is made through healthy structure; to prevent reunion, Dr. Mitchell approves Malgaigne's suggestion, that the distal end of the cut nerve should be doubled upon itself. It is almost needless to say that if the neuralgia appear to depend upon the irritation caused by a decayed tooth, or by a spiculum of necrosed bone, the effect of removing this should be tried before proceeding to any graver operation. Prof. Gross has described a form of neuralgia (of which I have myself seen two cases) depending upon a morbid condition of the alveolus, and curable by removing that part with cutting-forceps; and Drs. T. G. Morton and E. Mason have cured neuralgia of the metatarso-phalangeal joints by excison of the articulation. The operation of *stretching nerves* for neuralgia of traumatic origin has already been referred to at page 210, and the same operation has been employed in intractable cases of spontaneous origin by Mackintosh, Bramwell, Spence, Kocher, Nussbaum, Pooley, Bartleet, W. J. Morton, and other surgeons. Of 14 such cases collected by Gen, 10 were successful. The facial nerve has been successfully stretched in cases of spasm of the facial muscles by several surgeons, including Baum, Schussler, Eulenberg, Putnam, Southam, and Godlee. Walsham has successfully stretched the infra-orbital nerve, and Le-Dentu the lingual. The operation of nerve-stretching is not entirely free from risk, five cases recorded respectively by Socin, Langenbeck, Billroth and Weiss, Berger, and Benedikt, having terminated fatally.[1] *Ligation of the common carotid artery*, in cases of facial neuralgia, is advised by Weinlechner and Patruban, and has been successfully resorted to by F. H. Gross, of this city.

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[1] Nerve-stretching has been resorted to with more or less temporary benefit in a large number of cases of *locomotor ataxia*, but in other instances has proved useless, and in some has seemed to be positively injurious. Upon the whole, the weight of evidence is against the employment of the operation in this disease. Gillette has with advantage stretched the median and musculo-cutaneous nerves for *congenital epilepsy*. McLeod, of Calcutta, Lawrie, and Wallace have successfully resorted to nerve-stretching for *anæsthetic leprosy*, and benefit has been claimed from the operation by Langenbuch in cases of *pemphigus* and *senile prurigo*. R. M. Simon reports advantage from the same procedure in a case of *infantile paralysis*, and Blum in one of *hysterical tremor of the leg*, while W. J. Morton reports good results from nerve-stretching in *reflex epilepsy*, *paralysis agitans*, *athetosis*, *lateral sclerosis*, and *chronic transverse myelitis*.

TETANUS.

Tetanus is a disease of the nervous system, characterized by persistent tonic contraction of some or all of the voluntary muscles. In the large majority of cases tetanus results from a wound, or is *traumatic*, though it is also met with (especially in warm climates) as an *idiopathic* affection. Tetanus occurs in both sexes and at all ages; excluding, however, cases of *Puerperal Tetanus*, and of *Tetanus Nascentium* (which, according to Parrot, has much closer analogies with uræmic ecclampsia[1] than with true tetanus), it is by far most common in males in early adult life, though, probably, not disproportionately so, in view of the peculiar liability of these to be exposed to traumatic lesions. It occasionally occurs as an epidemic, and appears to be predisposed to by hot weather and by sudden changes of temperature. It is more frequent in the negro than in the white. *Traumatic tetanus* is the form of the disease which particularly demands the surgeon's attention. It may follow upon a mere contusion, such as the stroke of a whip, but is chiefly seen after punctured or lacerated wounds, or after burns and scalds; the extent of the wound appears to have no causative influence, the slightest being as often followed by tetanus as the most extensive injuries. It may occur after any surgical operation, without regard to its severity. Tetanus is more frequently met with in military than in civil practice, the proportion of cases in the Peninsular war having been 1 of tetanus to 200 wounded, in the Crimean war 1 to 500, in the Schleswig-Holstein campaign 1 to 350, and in our late war 1 to 242.[2] Exposure of the wounded to severe cold, and more particularly a sudden change from heat to cold, has been found a prolific source of tetanus in military surgery. The disease is apt to occur in those who are depressed or debilitated; it thus seems occasionally to follow in the wake of secondary hemorrhage.

Varieties.—Several varieties of tetanus have been distinguished, according to the group of muscles affected: thus, *Trismus*, or *Lock-jaw*, refers to the clenching of the teeth from tonic spasm of the muscles of mastication; *Opisthotonos*, to spasm of the muscles of the back, the patient with arched body resting merely on head and heels; *Emprosthotonos* (very rare), to a similar arching of the body in a forward direction; and right or left *Pleurosthotonos*, to a similar bending to one or the other side. Tetanus may occur very soon, even less than an hour, after the reception of a wound, or not for several weeks; usually, in temperate climates, from the fifth to the tenth day. The earlier the disease is developed, the more likely is it to prove fatal, cases occurring after the third week offering a comparatively favorable prognosis. *Acute* tetanus is much more fatal than the *chronic* form of the disease: of 327 cases of death from tetanus, analyzed by Poland, 79 occurred within two days, 104 in from two to five days, 90 in from five to ten days, 43 in from ten to twenty-two days, and 11 after twenty-two days. The most rapid death occurred in from four to five hours, while the longest duration of a fatal case was thirty-nine days.

Symptoms.—The symptoms of tetanus may come on suddenly, or may be gradually and insidiously developed; occasionally a feeling of general discomfort precedes for some time the characteristic manifestations of the disease, or there may be gastric and intestinal derangement, or the wound (if it have not healed) may become dry and unhealthy-looking. The first decided symptom is commonly a feeling of stiffness, with pain on motion, affecting the muscles of the lower jaw and tongue, and those of the back of the neck; in other cases, however, the cramps are first manifested in the muscles of the wounded limb. In a short time, great difficulty in chewing or swallowing is felt, and trismus soon becomes fully developed, with intense pain and slight tendency to opisthotonos; violent pain reaching from the precordial region to the spine, and doubtless due to spasm of the diaphragm, is now experienced, and forms a very characteristic symptom of the disease; the abdominal muscles become tense, hard, and board-like, and all the voluntary muscles, except those of the hand, eyeball, and tongue, become more or less involved. The countenance assumes a peculiar, old-looking expression, being pale, anxious, and distorted into the so-called *risus sardonicus* or tetanic grin. This distortion of face sometimes persists after recovery, and Poland refers to a case in which it was still apparent after eleven years. During the height of the disease, the body is often arched backwards, so that the patient is supported merely by his occiput and heels; while the muscular spasm is tonic, and never entirely disappears, it is paroxysmally aggravated—and the cramps are occasionally so violent as almost to hurl the patient from his bed; the pain is greatest during the cramps, which are also accompanied by profuse perspiration and great heat of skin (105°–110.75° Fahr., according to Dr. Radcliffe).[1] As the disease advances, the reflex excitability is much increased, the slightest touch or the least current of air being sometimes enough to bring on a paroxysm of cramp. Dyspnœa and want of sleep combine to render the condition of the patient still more deplorable. There is no delirium, and little or no fever, the heat of the skin being chiefly confined to the paroxysms, and the rapidity of the pulse being due to exhaustion rather than to febrile disturbance. Among the symptoms of less importance are constipation, retention of urine, priapism (probably due to spinal meningitis), aphonia, accumulation in the mouth and fauces of viscid saliva, self-inflicted lacerations of the tongue or cheek, and permanently dilated or contracted pupils. Death may occur in a paroxysm, from apnœa; or, at a later period, from simple exhaustion. There may be a certain degree of muscular relaxtion previous to death, or tetanic rigidity may be, as it were, directly transformed into rigor mortis.

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[1] According, however, to Marion Sims and P. A. Wilhite, of South Carolina, *tetanus nascentium* is a traumatic affection resulting from displacement of the occipital or of one of the parietal bones.

[2] 363 cases to 87,822 wounded. (Circular No. 6, S. G. O., 1865, p. 6.)

Pathology.—The pathology of tetanus is involved in much obscurity. I have called it a disease of the nervous system, because it is through the medium of the nerves and spinal cord that its phenomena are manifested, and because the nervous system alone has as yet been found to present post-mortem changes with sufficient constancy to be considered significant. It is, however, quite possible that, as suggested by Travers, J. A. Wilson, Richardson, and others, tetanus may eventually prove to be a blood disease, due to the absorption of some septic material. The *nerve* or *nerves* in the immediate neighborhood of the wound are commonly, though not invariably, found to be inflamed, lacerated, or contused, and it is at least possible that, even in those cases in which the nerves appear healthy, they may have been temporarily diseased, and that a nerve lesion has been really the starting-point of the affection. The *muscles* have frequently been found ruptured, and are, according to L. Conor, the seat of granular and fatty changes, such as have been observed in cases of typhoid fever. Duclaux has seen tetanus prove fatal through rupture of the heart. The most important post-mortem changes of tetanus are found in the *spinal cord*, and have been particularly investigated by Lockhart Clarke, Dickinson, Charcot and Michaud, Aufrecht, Stirling, and Coats, of Glasgow. The first-named writer ascertained, from an examination of six specimens, that there were, in several portions of the cord, marked patches of softening and disintegration affecting the gray matter, the cord itself being altered in shape. The structural change varied from mere granular softening to absolute fluidity, and was accompanied by numerous extravasations of blood. "In the walls of the bloodvessels there was no morbid deposit nor any appreciable alteration of structure, except where they shared in the disintegration of the part to which they belonged; but the arteries were frequently dilated at short intervals, and in many places were seen to be surrounded . . . by granular and other exudations, beyond and amongst which the nerve tissue . . . had suffered disintegration. We have reason, therefore, to infer that the lesions of structure had their origin in a morbid condition of the bloodvessels, resulting in exudations with impairment of the nutritive process."[1]

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[1] The temperature may continue to rise even after death; thus, in a case recorded by Wunderlich, the thermometer marked 108° before death, 112.5° at the time of death, and 113.5° a short time subsequently. Dr. Ogle, of London, and Dr. Keen, of this city, have recorded cases in which the evening was higher than the morning temperature.

The following are Mr. Clarke's conclusions as to the pathology of tetanus: (1) it is probable that these lesions are not present in cases which recover, or, if present, are so in but a slight degree; (2) these lesions are not the effect of excessive functional activity of the cord, but result from a morbid state of the bloodvessels; (3) these lesions are not the sole cause of the tetanic spasms, as similar lesions exist in cases of paralysis unaccompanied by tetanus; and (4) the tetanic spasms depend, *first*, on an abnormally excitable state of the gray nerve-tissue of the cord, induced by the hyperæmic and morbid state of its bloodvessels, with the exudations and disintegrations resulting therefrom (this state of the cord being either an extension of a similar state along the injured nerves from the periphery, or resulting from reflex action on its bloodvessels excited by those nerves), and *secondly*, on the persistent irritation of the peripheral nerves, by which the exalted excitability of the cord is aroused—the same cause thus first inducing the morbid susceptibility of the cord to reflex action, and subsequently furnishing the irritation by which reflex action is excited.

Dr. Dickinson's[2] observations tend to confirm those of Mr. Clarke, and add the interesting fact that the situations of the various lesions correspond anatomically with the side on which the injury exists. "The irritation from the left hand, conveyed, as we must suppose, by certain of the left posterior roots, occasioned especial congestion of the left posterior horn, and further changes in the white matter in contact with it—that is, in the left posterior and lateral columns. The central and anterior parts of the gray matter were most extensively affected on the side opposite to that of the injury, as might have been anticipated from the decussation in the cord of the sensory fibres. The irritation having reached any column or segment of the cord, appeared to diffuse itself throughout its whole length with undiminished intensity. Although the cervical region must have been the first recipient of the morbid influence, the lumbar part of the cord, both in the white and gray matter, was at least as severely affected." Charcot and Michaud note the same appearances that are described by Lockhart Clarke, but believe them to be due to exudation from the bloodvessels, and not to degenerative changes. It is in the posterior commissure of the gray matter of the cord, and especially in the lumbar region, that they have found what they regard as the "essential alteration" of tetanus; this consists in the development of a large number of nuclei which are variously disposed, and many of which are flattened from mutual compression; the changes are in fact the same as, though perhaps more marked than, those described by Fromman as occurring in cases of subacute myelitis. Coats has observed the morbid changes in the medulla oblongata, as well as in other portions of the spinal cord. Ringer and Murrell controvert the ordinary view that tetanus is due to increased excitability of the spinal cord, and believe that it is due to a diminished "resistance" of the cord, which allows impressions conveyed by the afferent nerves to spread through the reflex portion of the central nervous system. According to Ross, very much the same changes are found in tetanus as in hydrophobia, and this writer suggests that the differences in symptoms may be due to the cerebellum being more involved in the former, and the cerebrum in the latter, disease. Amidon has ingeniously tried to connect the various symptoms met with in tetanus with the several lesions discovered after death.

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[1] Med.-Chir. Trans., vol. xlviii. p. 264.

[2] Ibid., vol. li. pp. 265–275.

Diagnosis.—Tetanus may be distinguished from *spinal meningitis* by the early fixation of the jaw, and by the occurrence of paroxysmal spasms with permanent muscular rigidity in the intervals—the rigidity of spinal meningitis being, in a great degree, voluntarily assumed in order to prevent pain of motion. From *hydrophobia*, the diagnosis may be made by observing that, in the latter disease, the spasmodic movements are *clonic*, not *tonic*, that the face is convulsed and restless (no *risus sardonicus*), and that delirium is as common as it is rare in tetanus. From *poisoning by strychnia*, the diagnosis is sometimes very difficult, particularly if comparatively small quantities of that drug have been repeatedly administered. It is to be observed, however, that in strychnia-poisoning there may be complete intermissions between the paroxysms, and that (according to Poland) there is spasm of the muscles of respiration, with early and marked laryngismus, but no fixation of the jaw—the patient being able to open the mouth and swallow. Tetanus has been mistaken for *rheumatism*, and, on the other hand, *hysteria* has not unfrequently been mistaken for tetanus; the diagnosis, could, however, scarcely be very difficult, unless (as in a case mentioned by Copland) tetanus and hysteria actually coexisted in the same patient.

Prognosis.—The prognosis of *acute* tetanus is invariably unfavorable. It is doubtful whether there be any authentic case of recovery under such circumstances. In the *subacute* or *chronic* cases, the disease being developed at a comparatively late period, and running a less violent course, there is more hope of a successful issue, and by prompt treatment life may occasionally be preserved. It may be said in general terms that the later the development of the disease, the more chance is there of recovery.

Treatment.—This should be both general and local. The *General Treatment* should consist in the administration of such remedies as may diminish the morbid excitability of the spinal cord, and at the same time lessen the irritation of the peripheral nerves—it being probably to a combination of these two elements that the production of the tetanic spasm is due. At the same time, concentrated nutriment in a fluid form should be given as freely as practicable, for death frequently results, as has been seen, from pure exhaustion. The modes of treatment which have been proposed for tetanus are almost countless, including such diverse remedies as venesection, active stimulation, profuse purgation, and the induction of narcotism with opium. All means fail in acute cases—each has been occasionally successful in those of the chronic variety. The drugs which have obtained most reputation of late years have been opium, conium,[1] belladonna, cannabis Indica, woorara,[2] bromide of potassium, hydrate of chloral, and the Calabar bean. Of these the first and the two last are those upon which I should, at present, be disposed to place most reliance, and of which I would therefore recommend the employment. Eighteen cases collected by Dr. Eben Watson, in which the Calabar bean was used, gave ten recoveries and eight deaths; upon the whole, a favorable record. The bean may be given in large doses (Holthouse gave 4½ grains of the extract at once, the patient recovering), the only limit to its administration being the effect produced in controlling the spasms. It appears to act as a direct sedative to the spinal cord, and it has the additional advantage that it enables the patient while under its influence to take food with facility. It may be given by the mouth or rectum, or by hypodermic injection, a third of a grain of the extract being probably a large enough dose for the latter mode of administration. The sulphate of eserine has been successfully employed by Layton, of New Orleans. Opium in large doses may be properly given at the same time with the Calabar bean, as suggested by Holthouse, on account of its well-known sedative effect upon the peripheral nerves. Demarquay recommends the hypodermic injection of morphia into the masseter, or whatever muscle may be chiefly affected. From an analysis of nearly 400 cases, Knecht concludes that chloral is the most promising remedy, 157 cases in which this was given alone or in combination having furnished but 59 deaths—a mortality of less than 38 per cent. A cathartic may sometimes be required at the beginning of the treatment, to remove any irritating matters from the bowels, and concentrated food and stimulus must be given, throughout the case, in as large quantities as the patient can be induced to take. The inhalation of ether or chloroform may be occasionally resorted to with temporary benefit, and the application of an ice-bag to the spine might be tried, though its use should be watched, lest it induce too great depression. Tracheotomy has occasionally been resorted to, and, according to Richet, may be expected to be of service when spasm occurs in *expiration*. The inhalation of nitrite of amyl has been successfully employed by Foster, Curtis, Funkel, and Forbes, of this city.

The *Local Treatment* is likewise of importance: the wound should be explored, and any foreign bodies carefully removed. The afferent nerve or nerves (if any can be recognized) should be divided or partially excised, or, if the operation be otherwise indicated, amputation may be performed, if a limb be the seat of injury. *Nerve-stretching*, as suggested by Nussbaum and Callender, has been successfully resorted to by Verneuil, Vogt, Wheeler, W. J. Smith, Clark, Ratton, and Ransohoff, but in my own hands, as in those of most who have tried it, has failed to given even temporary relief, 33 cases to which I have references having given but 8 recoveries. Though *section of the nerve* will promise best if resorted to at an early period, it should not be neglected even at a later stage of the case. If no special nerve-lesion can be detected, a Λ incision down to the bone may be made, as advised by Liston and Erichsen, so as to insulate the part. The wound itself should be dressed with narcotics—particularly opium, in the form of laudanum, or a solution of sulphate of morphia (gr. v–f℥j), or, if the wound is sloughing, powdered opium with charcoal (℈j–℥j)—and in cases of burn or scald, this will often be the only local treatment which can be employed. The application of atropia to the end of the divided nerve, or by hypodermic injection, has occasionally been found useful. If the wound were already healed, it would be proper to dissect out the cicatrix, as the entanglement of a nerve filament in the scar might prove to have been the starting-point of the disease.

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[1] Hypodermic injections of conia have been used with some success by Prof. C. Johnston, of Baltimore.

[2] A recovery under the use of woorara has been recently reported by Dr. Maturin, an Irish surgeon.

Laurent has collected 54 cases of operation for the relief of tetanus, with 29 recoveries, classified as follows: neurotomy, 13 cases and 7 recoveries; minor amputation, 17 cases and 11 recoveries; and major amputation, 24 cases and 11 recoveries. Knecht's tables give 58 cases with 28 deaths. Letiévant reports 16 neurotomies with 10 recoveries. But, as justly remarked by E. Labbée, the recoveries have usually been in chronic cases, in which equally good results may often be obtained by internal treatment alone.

During the whole course of treatment, the patient should be kept in a rather dark, warm, and dry room, and should be carefully guarded from currents of air.

CHAPTER XXIX.

SURGICAL DISEASES OF THE VASCULAR SYSTEM.

DISEASES OF VEINS.

Phlebitis.—Phlebitis, or *Inflammation of a Vein*, may result from injury, or from the absorption of septic material. It is probably (as mentioned at page 173) by means of local inflammatory changes, in conjunction with coagulation of the contained blood, that veins are repaired after division or rupture; and this clotting or thrombosis of the venous contents is the most important element in connection with inflammation of a vein. It may be either a primary or a secondary phenomenon, either the cause or the consequence of the changes in the venous coats, to which the term phlebitis is applied; thus the phlebitis of pyæmia, and that seen after parturition (*phlegmasia dolens*), are the results of previous venous coagulation, while in many cases of lacerated wound, fracture, etc., the changes in the venous walls probably precede the formation of a clot. It is in the *outer coats* of a vein, according to H. Lee,[1] who has particularly investigated the subject, that the changes of phlebitis are chiefly found. The cellular coat becomes preternaturally vascular and reddened, and is at the same time distended with serum, lymph, or pus, either separately or commingled. The circular fibrous coat is similarly affected, but in a less degree, becoming injected and thickened. The inner coat loses its normal transparency, becoming wrinkled or fissured, of a dull whitish color, and more or less stained by the venous contents, its hue varying with that of the contained coagulum. The inner and outer coats of an inflamed vein may be separated by the products of inflammation, the various layers of the inner coat becoming disintegrated, or flakes of its lining membrane being cast off into the interior of the vessel. Phlebitis destroys the natural pliability of the venous coats, so that, when divided, an inflamed vein remains patulous like an artery.

The formation of a clot in an inflamed vein is caused, as pointed out by Schmidt, by the union of two substances always found in the blood, which he calls fibrinogen and fibrinoplastin; it is obviously designed by nature to prevent the entrance of morbid materials into the general circulation, and hence, when the clot is well formed, and in a healthy person, the disease is local and unattended with any particular danger. Dr. Nancrede, of this city, has ingeniously suggested that the extension of the clot depends upon the communication of lateral veins bringing fibrinogenetic material which results from the disintegration of tissue, and that hence when, in traumatic cases, the clot has reached beyond the point at which veins carrying such impure blood from the seat of disease reach the main channel, the process of coagulation is arrested. The clot undergoes changes, becoming partially organized, and converting the vessel into a fibro-cellular cord; or may contract so as to allow the partial resumption of the circulation; or may perhaps undergo a slow process of solution, and ultimately entirely disappear. Under other circumstances, the result is not so favorable: a large fragment of clot may become mechanically loosened and dislodged, and, being carried into the general circulation, may plug an important vessel (embolism), occasionally even causing a fatal termination, as has happened in cases of phlegmasia dolens; or, if the blood be in an unhealthy condition (as in pyæmia), and the clot imperfectly formed, disintegration may follow, with capillary embolism, leading to the formation of pyæmic patches, or the so-called metastatic abscesses (see page 418).

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[1] Practical Pathology, vol. i., Lectures II.–IV.

Symptoms.—An inflamed vein becomes hard, somewhat swollen, painful, and cord-like; it has, besides, a peculiar knobbed feel and appearance, the knobs corresponding to the positions of its valves. The course of the vein is marked by a distinct, dusky-red line, and the whole limb becomes somewhat stiff, and may be the seat of intense pain, sometimes of an intermittent or neuralgic character. There is always some œdema along the course of the vein and in the parts below, owing to the obstructed circulation and the consequent effusion of the fluid portion of the blood. This œdema may be soft, allowing pitting on pressure, or may be hard and tense. If the vein be deep-seated, the occurrence of tumefaction and pain may be the only evidences of phlebitis. The œdema usually subsides with the restoration of the circulation through the natural or collateral channels, though it may persist for a considerable period. The *constitutional disturbance* attending phlebitis is rarely of a grave character.

The conditions described by many writers as *suppurative* and *diffuse phlebitis* appear to be really examples of diffuse inflammation of the areolar tissue, or of cellular erysipelas, which often extend rapidly in the course of the veins, and which are apt to terminate in pyæmia. (See pages 394, 409, 417, and 517.)

Diagnosis.—The affection with which phlebitis is most likely to be confounded is *angeioleucitis*, which, however, may be distinguished by observing the brighter redness which it presents, and its invariable complication with adenitis. Deep-seated phlebitis may be mistaken for neuralgia, but the diagnosis may be made by observing that the *pain* of the latter affection is rather relieved than aggravated by pressure, and is not accompanied by œdema. The latter circumstance may also serve to distinguish inflammation of a vein from *neuritis.*

Prognosis.—Phlebitis *in itself* is rarely attended with risk to life; when, however, inflammation of a vein is a mere concomitant of pyæmia, or other grave constitutional condition, the question is very different; and even traumatic phlebitis, occurring in a person who is broken down in health, should be looked upon as a grave affection.

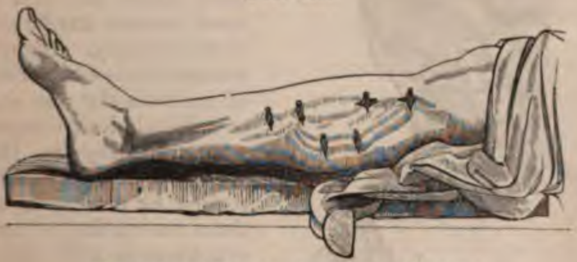
Treatment.—In the treatment of phlebitis, all depressing measures should be avoided, the chief risk of the affection being from deterioration of the general health and consequent disintegration of the venous coagulum. If the tongue be heavily coated, with fever and anorexia, half a grain of blue mass with two grains of quinia may be given every two or three hours, until about three grains of the mercurial have been taken, but beyond this the remedy should not, usually, be pushed. The quinia may be continued, eight or twelve grains being given in the course of twenty-four hours; and the muriated tincture of iron may be added, in combination with the spirit of Mindererus if the use of a diaphoretic be indicated. In milder cases, of course, less energetic measures will be required. The *diet* should be nutritious and easily assimilable, and *stimulus* may be given or withheld, according to the general condition of the patient, who should be kept in bed and at perfect rest. The *local treatment*, in mild cases, may consist merely in the use of warm fomentations or evaporating lotions, as most agreeable to the patient; but if the inflammation appear disposed to extend upwards, with severe constitutional disturbance, an effort may be made to prevent its spread by the operation proposed by H. Lee, which consists in acupressing a healthy portion of the vein at two points about three-fourths of an inch apart, and then dividing the vessel subcutaneously between them.

The œdema may be relieved by position, by gentle friction, and by the subsequent use of an elastic bandage.

Varix, Varicose Vein, or Phlebectasis, consists in a morbid dilatation of a vein, usually accompanied by thickening of its walls. Any veins may become varicose, but those most commonly affected are the veins of the lower extremity, scrotum, and rectum. The varicose condition may be limited to the principal venous trunks of the part, or may affect the subcutaneous venous plexus, giving the appearance of a network of a purple hue. The branches of the internal saphena are most frequently affected among the superficial veins, but it is probable that in the majority of cases the deep vessels are likewise more or less involved. The anatomical conditions of varicose veins vary in different cases: thus, together with the dilatation, there is often elongation, rendering the vessel tortuous; or the walls may be thinned instead of thickened; or the dilatation may be sacculated, forming pouches which generally correspond to the points of intercommunication with other veins. The *causes* of varicose veins are twofold: (1) such as pump into the veins an abnormal quantity of blood, as unusual muscular exertion, walking, etc.; and (2) such as mechanically impede the venous circulation, as the pressure of a tumor, or that of the pregnant uterus. A *depressed or feeble state of health* appears sometimes to act as a predisposing cause, while in some cases the occurrence of varicosity has been attributed to the effect of *hereditary influence*. Any *occupation* which requires the maintenance of the erect posture predisposes to varix. Varicose veins are rare in early life, and are rather more frequent in women than in men. The *symptoms* of superficial varix are easily recognized, the dilated and tortuous condition of the affected veins being quite characteristic. The patient often has a sensation of weight and fulness in the part, with some numbness, and occasionally loss of power, and frequently a dull, aching pain which is aggravated by exercise. The limb is sometimes œdematous. Deep varix is more difficult of recognition, the subjective symptoms commonly existing for some time before the implication of the superficial veins renders the nature of the disease apparent. *Muscular cramps* are, according to Mr. Gay, quite significant of a varicose condition of the deeper veins. Varicose veins are liable to be attacked by phlebitis and thrombosis, while inflammation of the surrounding tissues may lead to various troublesome conditions, such as the occurrence of eczema, or of ulceration (giving rise to the varicose ulcer), or to a scleromatous condition of the part analogous to the Arabian elephantiasis. A varicose vein occasionally gives way by rupture or by ulceration, the accident leading to profuse, or even to fatal, hemorrhage.

The *Treatment* of varicose veins may be either palliative or radical, the former being alone proper in the large majority of cases. The *Palliative Treatment* consists in giving support to the part, with gentle and equable pressure, by means of a flannel or India-rubber bandage, or an elastic stocking—the general health being maintained by the use of laxatives to prevent constipation, with tonics, especially the muriated tincture of iron, if, as usually happens, the patient be in a feeble and relaxed condition. Hemorrhage from a varicose vein may be checked by elevating the limb and applying a firm compress. The *Radical Treatment* may be employed if the varicose vein be evidently so altered in structure as to be useless for carrying on the circulation (particularly if it be also painful), if its coats be so attenuated as to threaten hemorrhage, or if it be connected with an ulcer which cannot be induced to heal. This mode of treatment consists in the obliteration of a portion of the vein, and it is radical as far as that portion is concerned, though it by no means insures a cure of the general disease, which, indeed, in most instances, must be looked upon as incurable. Various means have been proposed for the obliteration of varicose veins, such as (1) the application of caustic, so as to form eschars over the line of the vessel, or, as recently suggested by Linon, the application of a strong solution of the sulphate of iron; (2) the injection of coagulating agents (chloral is particularly recommended by Porta, and other Italian surgeons); (3) the hypodermic injection of ergotin or alcohol; (4) the passage of an electric current through the vessel; (5) the subcutaneous section of the vein; (6) its compression at various points by means of a pin passed beneath the vessel, with a compress or piece of bougie above, the two being fastened together with a thread, or wire, in the form of a figure-of-8 (Fig. 248);[1] (7) the application of a metallic ligature; (8) simply denuding and isolating the vein, as recommended by Rigaud, Cazin, and Bergeron; and (9) excision of a part of the vein, a Celsian mode of treatment recently revived by Marshall, Steele, Howse, Davies-Colley, and Dunn. Probably the best plan is that recommended by H. Lee, which consists in (10) securing the vein at two points, about an inch apart, by passing acupressure-needles *beneath*, but not through, the vessel; applying, over the ends of the needles, elastic bands or figure-of-8 ligatures; and then subcutaneously dividing the vein at an intermediate point. The needles, which are removed in three or four days, serve to approximate, without injuring, the sides of the vein, while obliteration of the vessel takes place at the point of subcutaneous section, the parts healing in about a week.

FIG. 248.



Application of pins to varicose veins. (MILLER.)

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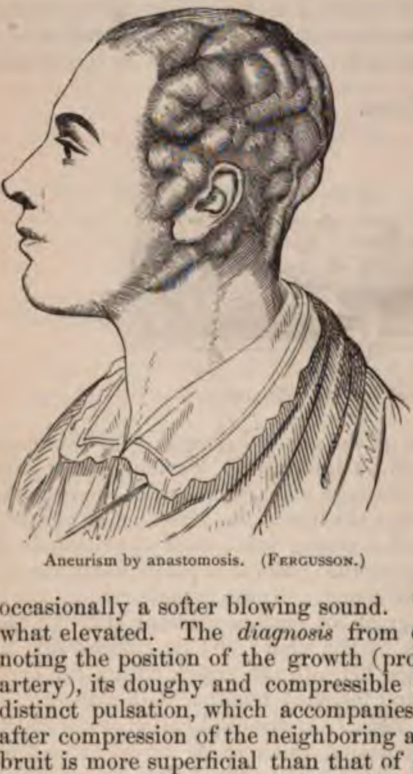
[1] A special instrument for compressing veins in this manner is employed, under the name of "vein-brooch," by Mr. J. R. A. Douglas, of Hounslow.

Vascular Tumors or Angeiomata.[1]

(*Arterial Varix, Aneurism by Anastomosis, Nævus.*)

Fig. 249.



Aneurism by anastomosis. (Fergusson.)

Arterial Varix or Cirsoid Aneurism is a disease which consists in the simultaneous elongation and dilatation of an artery. When, as is frequently the case, the capillary network is also involved, the disease receives the name of **Aneurism by Anastomosis or Racemose Aneurism,** but the two affections are, in every essential respect, the same. The vessels become tortuous, and in parts sacculated, their coats (especially the middle) being thin, and causing the artery to resemble a vein. This affection is most common about the scalp and face, but may occur in other parts, as the tongue, extremities, internal viscera, and bones; it is chiefly met with in early adult life, and its development is often attributed to a blow or other injury. Aneurism by anastomosis forms a tumor or outgrowth, of variable size and shape, usually of a bluish hue, compressible, and communicating to the touch a spongy or doughy sensation, accompanied by a whiz or thrill, sometimes amounting to pulsation, and synchronous with the cardiac impulse. This thrill disappears when the arteries leading to the tumor (which are themselves usually dilated and tortuous) are compressed, and returns with an expansive pulsation when the pressure is removed. Auscultation gives usually a loud, superficial, cooing bruit, though occasionally a softer blowing sound. The temperature of the part is somewhat elevated. The *diagnosis* from ordinary aneurism may be made by noting the position of the growth (probably at a distance from any large artery), its doughy and compressible character, and the thrill, rather than distinct pulsation, which accompanies the re-entrance of the blood, when, after compression of the neighboring arteries, the pressure is removed. The bruit is more superficial than that of aneurism, and compression of the arterial trunks does not so completely mask the physical signs of the disease as in that affection, blood still entering the part from other sources. When occurring in bone, aneurism by anastomosis may be mistaken for encephaloid, with which, indeed, it may co-exist.

The *treatment* should vary with the size and position of the growth. *Excision* or *Ligation*, in the way which will be described when we come to speak of nævus, is the mode of treatment to be preferred when the affection is not very extensive, and suitably situated, as on the lip, scalp, or extremities. If excision be employed, the knife must be carried wide of the disease, in order to avoid profuse or possibly fatal hemorrhage.

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[1] See page 488.

If the tumor be too large for ligation or excision, it will usually be prudent not to interfere, unless the integument be so thinned as to threaten rupture. When it is decided to operate, several methods are open to the surgeon, the most promising being electro-puncture, the injection of coagulating fluids, and deligation of the main artery of the part. The use of coagulating injections is generally preferred by French surgeons; Broca has reported a case in which, after the failure of acupressure to the nutritive arteries, he effected a cure by injections of perchloride of iron, the passage of the styptic being limited by surrounding the points of injection with rings of lead, and the tumor being attacked in sections by dividing it into lobes by means of tubes of caoutchouc. Bigelow has succeeded by the injection of a saturated solution of nitrate of silver. Heine, from a study of sixty cases, concludes that, for small tumors, simple excision is the best remedy, while for those which are larger, preliminary ligation of the carotid or nutrient arteries, and subsequent excision at one or more sittings, are to be preferred. Ligation of the main artery is the plan which has been most frequently employed, particularly when the affection has involved the orbit. In such a case the primitive carotid is the vessel to be tied; but if the disease were limited to the scalp, it might be better to adopt Bruns's suggestion, and tie one or both external carotids instead. Thirty-one cases of ligation of the common carotid for erectile tumor, etc., tabulated by Norris, gave eighteen recoveries and eight deaths. In other cases, again, it might be preferable to tie the various arteries in the immediate vicinity of the vascular growth, surrounding the latter at the same time by deep incisions, as was successfully done by Gibson. The only treatment to be recommended for aneurism by anastomosis occurring in the long bones is amputation.

Nævus is an affection very analogous to the preceding, but differs from it in involving chiefly the capillaries or veins. When congenital, nævus constitutes the so-called *mother's mark.*

1. *Capillary Nævi*, which are commonly, if not always, congenital, occur as flattened elevations, of a red or purple hue, usually upon the face or upper part of the trunk, but occasionally in other situations. They may involve a considerable extent of surface, but rarely give any annoyance except from the attendant deformity. Sometimes, however, they ulcerate and bleed. They consist of a congeries of capillary vessels, and may accompany the aneurism by anastomosis on the one hand, or the venous nævus on the other.

2. *Venous Nævi* occur as prominent tumors or outgrowths, of a reddish-purple hue, smooth or lobated in outline, and somewhat compressible, doughy, and inelastic to the touch; they are less exclusively confined to the upper part of the body than the capillary nævi, and, in their structure, consist of thin, tortuous, and sacculated veins, often interspersed with cysts. Venous nævi may occur *subcutaneously*, when they form tumors which may be partially emptied by pressure, slowly filling again when the pressure is removed, and becoming distended by violent exertion or struggling on the part of the patient.

Treatment.—Cutaneous nævi which are small and not disposed to spread, may often be left without treatment—when they may disappear spontaneously; and, on the other hand, a nævus may involve such a large extent of surface as to forbid any attempt at its removal. The shrivelling of small cutaneous nævi may sometimes be hastened by the application of tincture of iodine. Bradley, of Manchester, recommends tattooing with carbolic acid, and an ingenious instrument for the purpose has been devised by Sherwell, of Brooklyn, who supplements the operation by compressing the part by the application of collodion. For the treatment of the diffused form of nævus known as "port-wine stain," B. W. Richardson advises the application of the ethylate of sodium, while Squire recommends linear scarification with a frozen scalpel, followed by compression, the part itself being first frozen with the ether-spray apparatus. The last-named surgeon has also devised an ingenious instrument for the purpose, consisting of a number of thin knife blades placed closely together; the incisions are best made in an oblique direction to the surface. Moderately large, or subcutaneous, or even small cutaneous nævi, if they are so placed as to cause disfiguration, may be removed by several methods. Various plans have occasionally proved successful, such as *vaccination* over the growth, the use of a *seton*, the application of *styptics* or *vesicants*, the introduction of *heated wires*, *electro-puncture*, or *subcutaneous discission* with *compression;* the best modes of treatment, however, are commonly the application of *caustics*, the use of *coagulating injections*, *excision*, and *ligation*.

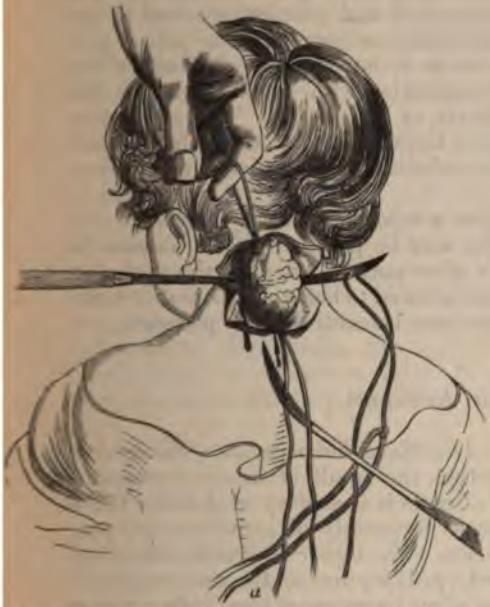
(1.) When the nævus is superficial, and so situated that the presence of a scar will not be particularly objectionable, the application of *nitric acid* or the *Vienna paste* may suffice to effect a cure, the application being repeated if there be any tendency to a recurrence of the affection. *Sodium ethylate* is recommended by Dr. B. W. Richardson and Dr. J. Brunton in preference to nitric acid, as causing less destruction of the epidermis.

(2.) Injection of a solution of the *perchloride* or *persulphate iron*, by means of an ordinary hypodermic syringe, may be employed for small nævi in certain situations, as the eyelid or orbit, where other modes of treatment would be inapplicable; the quantity injected should be very small (not more than two or three drops at a time), and compression should be made upon the returning veins, lest some of the injected fluid should enter the general circulation, and perhaps cause death, as has actually occurred in cases recorded by Kesteven, Bryant, West, and others.

(3.) *Excision* may be practised when the nævus is of large size, and in the form of a distinct tumor, the incisions being carried wide of the disease, except when, as occasionally happens, the growth is surrounded by a capsule, and when therefore, as advised by Teale, *enucleation* may be safely practised. This condition is, according to Erichsen, most common in cases of nævus associated with fatty or cystic growths. Owen recommends excision with Paquelin's thermo-cautery as applicable to the largest nævi.

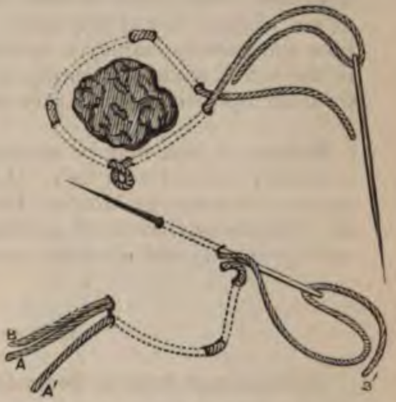
(4.) *Ligation* is in most instances the best mode of treatment, and may be applied in several ways. If the nævus be small, it may be sufficient to pass harelip pins in a crucial manner beneath the growth, and throw a ligature around their ends, or a *double ligature* may be introduced, and the nævus tied in two halves. In other cases the *quadruple ligature* should be employed. This may be applied by passing beneath the nævus two strong needles, eyed at the points, and crossing each other at right angles—the skin over the growth being, if healthy, previously reflected in flaps by means of a crucial incision (Fig. 250). The needles may be passed unarmed, the ligatures—which may be of strong silk or whipcord—being introduced as they are withdrawn. The nooses are then cut, and an assistant holds six ends firmly, while the surgeon knots the other two, this process being repeated until the whole nævus is strangulated in four sections. Another method is to apply the ligature *subcutaneously*, as shown in Fig. 251, taken from Holmes. When the nævus is flat or elongated, a better plan is that described by Erichsen, which consists in passing a double ligature of whipcord, three yards long and stained black for half its length, in such a way as to have a series of double loops, about nine inches in length, on each side of the tumor (Fig. 252). The black loops being then cut on one side, and the white on the other, the ends are secured as in Fig. 253, so as to strangulate the growth in numerous sections. After the operation the tumor sloughs, and comes away in a few days, leaving an ulcer which heals by granulation. Various modifications must be adopted, according to the locality of the disease. In dealing with a nævus over the fontanelle, there might be some risk, if the ordinary needles were used, of puncturing the membranes of the brain; and hence in this situation, after incising the skin with a lancet, the ligature should be carried beneath the growth by means of an eyed probe. The scalp is so adherent to a nævus in the cranial region that no attempt should

FIG. 250.



Nævus; application of the quadruple ligature. (LISTON.)

FIG. 251.



Subcutaneous ligature of nævus. The upper figure shows a single ligature carried round the tumor. The lower (in which no tumor is depicted) shows a double string carried below the centre of the base, then divided into two, A A′ and B B′, and each of the two carried subcutaneously round half of the nævus, and then tied. (HOLMES.)

FIG. 252.

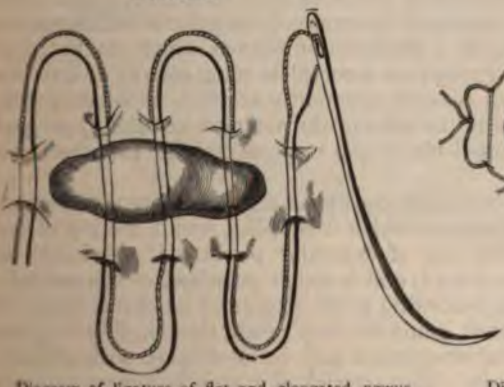


Diagram of ligature of flat and elongated nævus. (ERICHSEN.)

FIG. 253.

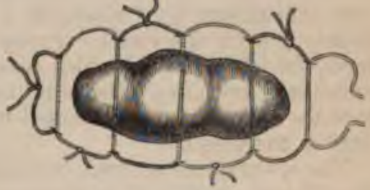


Diagram of tied flat and elongated nævus. (ERICHSEN.)

usually be made to preserve the skin in this locality. For nævus of the tongue, the use of the *écraseur* may be advantageously substituted for that of the ligature. H. Lee has recently recommended, in cases of vascular tumor of the face and neck, the use of *India-rubber thread*, instead of the common ligature, the elastic contraction of this agent serving to divide the tissues without hemorrhage, and thus effecting rapid and painless removal of the morbid growth. Barwell suggests subcutaneous strangulation with a wire tightened every three or four days, so as to cut through the base of the nævus without loss of any skin. Strangulation with acupressure pins has been successfully employed by Bontflower, of Manchester. Though ligation is the safest mode of treating nævus, I have once met with a fatal result from the operation, apparently due to embolism of the pulmonary artery.

Moles.—A *mole* may be considered as a superficial variety of nævus, and is usually covered with hair. *Excision* may be practised, if the disease be not too extensive, or Morrant Baker's plan may be adopted, the surface of the mole being shaved off, and the part allowed to heal under a scab. Hemorrhage during and after the operation may be controlled by pressure.

DISEASES OF ARTERIES.

Arteritis and Arterial Occlusion.—*Arteritis, or Inflammation of the Arterial Tunics*, may occur as a primary affection, the result of injury or exposure to cold, but in the immense majority of cases is secondary to *Arterial Occlusion*, the result of thrombosis, or more frequently of embolism, the plug being derived from a fibrinous heart-clot. The repair of arteries after division is, as has already been mentioned (p. 179), due to the formation of a clot, together with the union of the cut edges by means of local inflammatory changes. The alterations in the arterial coats produced by inflammation are analogous to those which we have studied in the walls of a vein, as the result of phlebitis. Thus the external coat and sheath become vascular, pulpy, and distended with the products of inflammation; the middle coat contracted, thickened, and softened; while the inner loses its smooth and polished appearance, and becomes pulpy and stained from contact with the coloring matter of the blood. The clot which forms in cases of arteritis, and which indeed, as has been said, is commonly the cause of the arterial inflammation, may consist merely of masses of a fibrinous substance, which do not completely occlude the vessel—or may form a complete plug, usually of a conical form, the lower part of which consists apparently of white blood-corpuscles and fibrin, and often adheres to the sides of the artery, while the upper part is of the color of ordinary clotted blood, and projects tail-like into the upper part of the vessel.

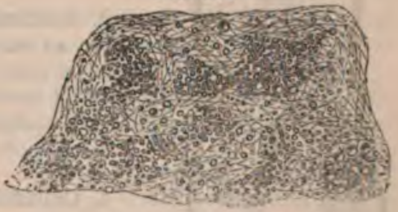
The *symptoms* of arterial occlusion consist of acute pain in the course of the affected artery, and in the parts which it supplies, with a feeling of tension, great hyperæsthesia, and loss of muscular power. If the artery be superficial, it can be felt as a cord, and is either pulseless, or the seat of a sharp and jerking pulsation, according to the degree of its obstruction. If the artery be one of importance, gangrene may result, though, in young and healthy subjects, the collateral circulation may be established with sufficient promptness to avoid this result. The arterial clot may become organized, the vessel being converted into a fibro-cellular cord; or a fragment may be detached and plug the artery at a lower point (this double occlusion almost invariably producing gangrene); or the clot may become completely disintegrated, and capillary embolism (*arterial pyæmia*) result.

The *treatment* consists in the administration of opium to relieve pain, and of tonics, stimulants, and concentrated food, to maintain the patient's strength, with application of external warmth to the affected part in order to avert mortification. The subject of gangrene as the result of arterial occlusion, and the question of amputation under such circumstances, have been sufficiently considered in previous chapters (pages 91, 196).

Chronic Structural Changes in Arteries.—The most important of these are *Fatty Degeneration*, *Atheroma*, *Ossification*, and *Calcification*.

1. Fatty Degeneration occurs in the inner coat of arteries, especially the aorta, carotids, and cerebral arteries, giving rise to small, rounded or angular, whitish spots, which project slightly above the surface; the fatty change takes places in the connective-tissue corpuscles of the part, and at a later period, the intermediate substance softening, the masses of fat granules fall apart, and, the current of blood carrying away the fat particles, velvety-looking depressions are produced, which constitute a form of what Virchow calls *fatty usure*.[1]

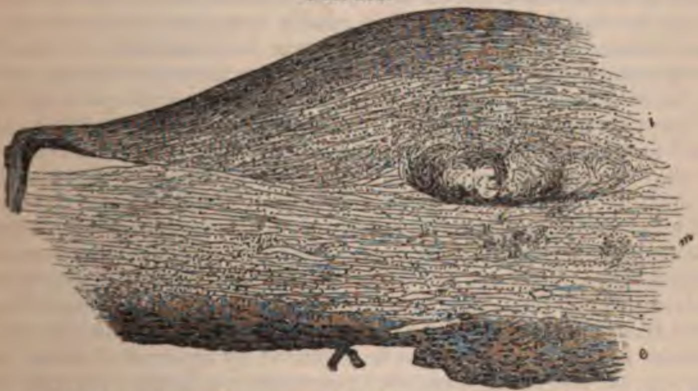
FIG. 254.



Fatty degeneration in inner coat of aorta. (GREEN.)

2. Atheroma, which is usually accompanied by the fatty change of the internal coat above described, appears to occur primarily in the external layer of the inner coat, at the junction of the latter with the middle coat, and forms a pultaceous (or *atheromatous*) mass, consisting of granular matter, fat globules, plates and crystals of cholestearine, and half-softened fragments of tissue which have not yet undergone degeneration. During the early stage of atheroma, the appearance presented is that of a whitish, somewhat elevated spot, project-

FIG. 255.



Atheroma of the aorta, showing the new growth in the deeper layers of the inner coat, and the consequent internal bulging of the vessel. The new tissue has undergone more or less fatty degeneration. There is also some cellular infiltration of the middle coat. *i*. internal, *m*. middle, *e*. external coat of vessel. (GREEN.)

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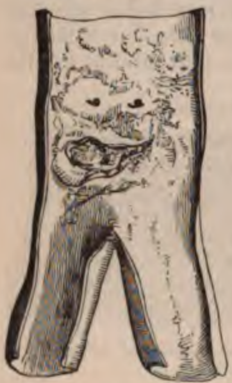
[1] Cellular Pathology, Chance's transl., pp. 339–340.

ing into the vessel, but still covered by a portion of the inner coat of the latter[1] (Fig. 255). As the process continues, the inner coat becomes perforated, the atheromatous mass is evacuated into the vessel, and the so-called *atheromatous ulcer* results (Fig. 256), just as in the affection known as ulcerative endocarditis. While this change is occurring between the inner and middle coats of the artery, its outer coat becomes thickened and indurated, thus tending to maintain the strength of the vessel, which at the same time becomes comparatively rigid and inelastic. Atheroma is usually spoken of as a *degenerative* change, but, according to Virchow, Billroth, Niemeyer, W. Moxon, and others, should be considered a result of inflammation. Atheroma is often supposed to occur as a sequel of syphilis, but, according to Heubner and Ewald, the syphilitic degeneration met with in arteries is a distinct affection (see page 460).

FIG. 256.



Atheromatous ulcer of aorta. (LISTON.)

3. Ossification is a rare, but, according to Virchow, an occasional change met with in the inner arterial coat. It may coexist with or may take the place of the atheromatous change (*atheromasia*), and, like that, results, according to Virchow, from inflammatory proliferation.

4. Calcification is frequently met with, and, unlike atheroma, often in the peripheral arteries; it occurs chiefly in the middle coat of the vessel, and has no necessary connection with the atheromatous change. It consists in the deposit of earthy matters, principally phosphate, with a little carbonate, of lime, and occurs in the form of plates, rings, or tubes, constituting the several varieties of the affection known as *laminar*, *annular*, and *tubular calcification*. When in the superficial arteries, it is readily recognized by the touch.

These various structural changes may exist independently, or, as is more common, may coexist in the same person. They may occur at any age, but are by far most frequently seen in those who have passed the period of middle life. They are more frequent in men than in women, and are said to be predisposed to by intemperate habits and by syphilis; when occurring in the limbs, they are usually symmetrical. The effect of these structural changes is, in the first place, to diminish the calibre of the affected artery, and secondly, by lessening its natural resiliency, to lead to its irregular dilatation and elongation; hence, an atheromatous or calcified artery may become tortuous, and is peculiarly apt to become the seat of aneurism. Rupture may take place through an atheromatous ulcer, and lead to fatal hemorrhage, as has been occasionally seen in the aorta;[2] while both atheroma and calcification render an artery more apt to be ruptured by external violence, and interfere with the success of hæmostatic measures—a ligature perhaps cutting through at once, or becoming prematurely detached and leading to secondary hemorrhage. Finally, the loss of smoothness in the lining surface of an atheromatous or calcified artery, hinders the circulation, and offers a nidus for the occurrence of arterial thrombosis, thus leading indirectly to occlusion and perhaps gangrene, as in several cases collected by H. Lee; or, on the other hand, particles detached from an atheromatous ulcer may produce capillary embolism, and give rise to one form of arterial pyæmia. Little can be done in the way of *treatment* for these structural changes, beyond attention to the general health of the patient; if wide-spread, they would of course render the surgeon cautious in recommending any cutting operation that was not imperatively required. Should occlusion and gangrene occur, the case should be treated on the principles laid down in previous portions of the work.

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[1] Mr. Moore, in his essay in *Holmes's System of Surgery*, vol. iii., adopts the view formerly held by Rokitansky, that atheroma is a deposit *on* the lining membrane of the artery, derived from the blood.

[2] Similarly, fatty degeneration of the cerebral arteries is a very common antecedent to the occurrence of apoplexy. (See Paget, *Lectures on Surgical Pathology*, 3d edit., p. 106.)

ANEURISM.

Aneurism, as the term is used in this work, is a disease of the arteries, consisting in a circumscribed dilatation of one or more of the arterial coats.

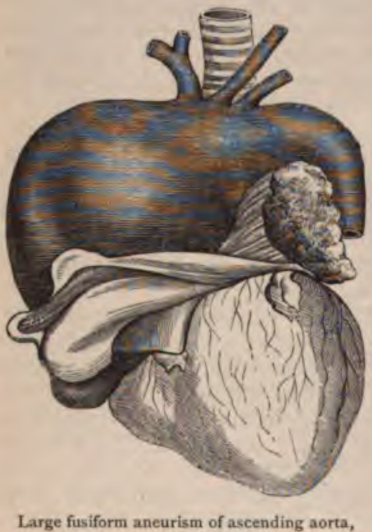
Varieties.—We have already considered those forms of aneurism which result from *wounds* (see page 197), as well as the *general dilatation* of an artery which constitutes the disease known as *arterial varix* or *cirsoid aneurism;* there remain for discussion three varieties of aneurism, which may be called respectively: 1, the *tubular* or *fusiform;* 2, the *sacculated;* and 3, the *dissecting aneurism.*

1. Tubular or Fusiform Aneurism.—This is a circumscribed dilatation of all the coats of an artery, in its whole circumference. It is accompanied by elongation of the vessel, with thickening and structural change of its coats. It is most common in the aorta, but also occurs in the iliac and femoral arteries, and has been seen in the basilar artery. Several fusiform aneurisms may coexist in the course of the same vessel, the intervening portions of the artery remaining healthy. Tubular aneurisms of the aortic arch may attain a very large size, running a chronic course, and doing harm chiefly by pressure on important parts. They may cause death by impeding the circulation, and thus causing syncope; or by compressing other parts, as the œsophagus or bronchi; or, when occurring in the intra-pericardial portion of the aorta, by bursting into the pericardial sac (Fig. 257). More commonly, however, a *sacculated* aneurism (Fig. 258) forms upon one or other side of the *tubular* dilatation, and, becoming the more important disease, leads more rapidly to a fatal result.

2. A Sacculated Aneurism is a sac-like dilatation which forms upon one side of an artery, or of a previously existing fusiform aneurism, and which communicates with the interior of the vessel by means of a comparatively small orifice, called the mouth of the sac. Sacculated aneurisms are divided into *true* and *false;* the *true sacculated aneurism* being one in which all the arterial coats enter into the formation of the sac-wall, and the *false sacculated aneurism* (which is by far the more common) being one in which, the inner and part of the middle coat having given way, the sac-wall is formed by the thickened outer coat of the artery, with perhaps the external layers of the middle coat. A *true* sacculated aneurism must be of small size, and with a large mouth to its sac; for it is scarcely conceivable that a large sac could be formed from the portion of arterial wall corresponding to the area of a small sac-mouth. It is very probable, however, that a considerable number of sacculated aneurisms are at first *true*, and subsequently, as they increase in size, become *false* by rupture of the inner coats of the sac-wall. *False sacculated aneurisms* are further classified by surgical writers as *circumscribed* and *diffused*, the aneurism being circumscribed as long as its sac remains entire, and becoming diffused when its sac gives way—the contained blood being then either widely spread among the adjoining tissues, or being still confined by an adventitious envelope of condensed connective tissue. The subdivision of aneurisms into true and false is not of much practical importance—the fact being that it is often impossible, even after careful dissection, to distinguish one from the other; while a diffused aneurism is in reality nothing more than an aneurism the sac of which has given way.

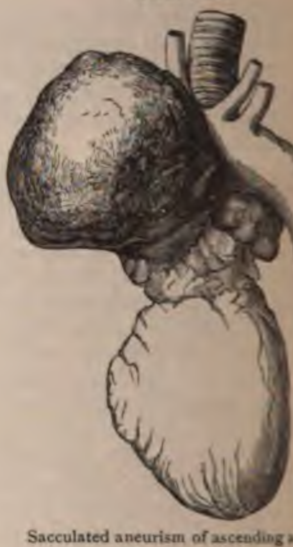
3. Dissecting Aneurism is almost exclusively met with in the aorta, and is a rare form of the disease, in which the blood makes its way between the coats of the artery itself. A sac may thus be formed in the arterial wall; or the blood may dissect up the coats of the vessel for some distance, at last bursting through the external tunic, and probably causing death by syncope; or, finally, the blood may re-enter the artery through a softened patch of the inner coat, thus giving the appearance of a double aorta. The only contingency in which a dissecting aneurism would be likely to demand the special attention of the surgeon would be in case the pressure of the effused blood should threaten gangrene, by occluding the trunk of the affected vessel.

FIG. 257.



Large fusiform aneurism of ascending aorta, bursting into pericardium. (ERICHSEN.)

FIG. 258.



Sacculated aneurism of ascending aorta. (ERICHSEN.)

Causes of Aneurism.—The chief *Predisposing Cause* is unquestionably the existence of structural changes (particularly *fatty degeneration* and *atheroma*) in the arterial walls. *Calcification* does not directly tend to cause aneurism, but rather lessens the dilatability of the artery which it affects; it has, however, an indirect influence, the want of elasticity which it produces tending to increase the strain upon other portions of the vessel, and thus predisposing them to aneurismal disease. *Age* has been looked upon as a predisposing cause, aneurism usually occurring during the middle period of life; the explanation is, that at this age, while atheromatous changes have begun, the laborious occupations of youth are commonly still continued. Similarly, though aneurism is unquestionably much more frequent in the male *sex* than in the female (about seven to one[1]), it is probably not more so than might be expected from the greater liability of men to structural arterial changes, and from their being more commonly engaged in occupations which themselves predispose to aneurismal disease. Any *occupation* which requires intermittent violent muscular exertion predisposes to aneurism, by inducing occasional violent action of the heart, and consequent over-distention of the arteries; thus hotel-porters, soldiers, and sailors, or those who, usually leading sedentary lives, indulge occasionally in athletic sports, are said to be more liable to aneurism than those whose occupation is uniformly laborious. *Climate* appears to exercise some predisposing influence, aneurism being probably more common in the British isles, and particularly in Ireland, than in any other portion of the world. The disease is comparatively rare in this country. Anything which tends to *obstruct the arterial circulation* may predispose to aneurism by increasing the tension of the arterial walls; it is thus, as we have seen, that calcification produces its effect, and it is thus that aneurism may be developed above the seat of occlusion of an artery by embolism,[2] or above the point of application of a ligature. The *position* of an artery may itself predispose the vessel to aneurism; thus the exposed situation of the popliteal artery renders it peculiarly liable to the development of aneurismal disease.

The *Exciting Causes* of aneurism are wounds, blows, and sudden strains. The effect of wounds has already been considered (see page 197); blows and strains, which may cause rupture of a healthy artery, may still more readily induce partial dilatation of one which is weakened by disease, thus giving rise to a tubular or to a true sacculated aneurism; or (which is commoner) may cause the giving way of the portion of the inner coat which covers an atheromatous patch, leading to the evacuation of the latter, and the consequent formation of a false sacculated or of a dissecting aneurism, according to the particular circumstances of the case.

Number, Size, and Structure of Aneurisms.—Aneurisms are usually single, but two or more may coexist in the same person. When aneurisms are multiple, they may affect one or different arteries; thus there may be an iliac and a femoral, or a femoral and a popliteal aneurism in the same limb, or, on the other hand, a popliteal aneurism may coexist with one of the subclavian or carotid artery, or with one of the aorta. Popliteal aneurism is frequently symmetrical. When a large number of aneurisms coexist, as in cases recorded by Pelletan and Cloquet, the patient is sometimes said to suffer from the *aneurismal diathesis*.

Aneurismal tumors vary in *size*, from that of a pea,[3] to that of a child's head; the size varies in different situations, according to the degree of resistance offered by surrounding parts, and the force of the distending blood current. The largest aneurisms are hence commonly those which occur in the aorta, or, externally, in the axilla, neck, groin, and ham.

If a *sacculated* aneurism is laid open, its *structure*, going from without inwards, is found to be as follows: (1) An investment of condensed areolar tissue, forming an adventitious sac; (2) the true aneurismal sac, consisting either of the thickened external, with, perhaps, part of the middle, coat (*false aneurism*), or of all the coats (*true aneurism*), in which case the inner and middle coats may sometimes be recognized by the atheromatous and calcareous patches which they contain; (3) concentric layers or laminæ of decolorized fibrinous clot, which appear to have been successively separated from the blood, as if by whipping,[1] and of which the inner layers are softer and redder[2] than the outer; and (4) an ordinary loose "currant-jelly" coagulum, which may be either of ante-mortem or of post-mortem formation. The laminated fibrinous coagulum serves an important purpose in strengthening the sac-wall, lessening the containing capacity of the sac itself, and, by its tough and inelastic character, diminishing the force of the arterial current in the sac, thus, in every way, tending to limit the spread of the disease, and even to lead to its spontaneous cure. The *mouth of the sac*, which is round or oval in shape, is of variable size, but always of much less area than a section of the sac itself; in a false aneurism the inner and usually the middle coat cease abruptly at the mouth of the sac, and even in a true aneurism they can rarely be traced for more than a short distance beyond the same point. The structure of the *tubular*, and that of the *dissecting*, form of aneurism have already been referred to (pp. 545, 546); another point in which these differ from the sacculated aneurism is in containing little or no laminated fibrinous clot.

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[1] In the *internal* aneurisms the proportion is four to one, and in the *external* (excluding carotid aneurism, which affects both sexes equally) it is thirteen to one; *dissecting* aneurism is twice as frequent in women as in men (Crisp, *Structure, Diseases, and Injuries of Bloodvessels*, p. 115).

[2] According to Church, embolism is the most frequent cause of intracranial aneurism in young persons (*St. Bartholomew's Hosp. Reports*, vol. vi. p. 99).

[3] The *miliary aneurisms* found by Charcot and others in the capillary vessels of the brain, in cases of apoplexy, are much smaller, the diameter of these aneurisms rarely exceeding a *millimetre*, or about $\frac{1}{25}$ of an inch.

Symptoms of Aneurism.—Patients are sometimes conscious of the formation of an aneurism—experiencing a distinct sensation of something having given way, or a sharp pain, as if from the stroke of a whip—or (as in the case of intra-orbital aneurism) hearing a sudden sound, as of the explosion of a percussion-cap—a small, pulsating tumor being, perhaps immediately, or soon after, discovered upon examining the part. In other cases, the development of an aneurism is very gradual, the patient perhaps not becoming aware of its existence until it has attained a considerable size. The symptoms of aneurism may be divided into those which are peculiar to the aneurismal nature of the affection, and those which depend merely upon its size or position—its *pressure effects*—and which might equally be due to any other tumor of the same bulk, and in the same locality. The *peculiar symptoms* of aneurism are made apparent by auscultation and manual examination, and depend upon the flow of blood through the aneurismal tumor, and, in the case of the ordinary sacculated form of the disease, upon the communication which exists between the sac and the artery upon which it is developed; in certain internal aneurisms, the auscultatory signs alone are available for diagnosis.

General Characters.—An external aneurism presents the appearance of a rounded or oval tumor, situated in the course of a large artery, somewhat compressible and elastic, and becoming flaccid by pressure on the artery above, and tense by pressure on the artery below, the tumor. If the aneurism contain but little laminated clot, it will be quite soft and compressible, but if, on the other hand, the sac contain a large amount of fibrinous clot, it will be comparatively hard and inelastic; the skin over an aneurism is usually healthy, though stretched; as the tumor grows it may, however, become discolored, thinned, or even ulcerated, and suppuration may occur in the subcutaneous areolar tissue. Muscular weakness of the part, stiffness, and a tired feeling, are frequent accompaniments of aneurism.

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[1] This is denied by W. Colles, who believes that the laminated coagulum is formed by the walls of the sac itself.

[2] In a case observed by H. D. Schmidt, however, the older and harder layers of fibrinous coagulum presented the darker color—the difference probably depending, as suggested by this writer, rather upon the amount of hæmoglobin contained in the respective layers than upon their relative ages.

Pulsation.—The pulsation of an aneurism is peculiar, being of an eccentric, expansive character, separating the hands when placed on either side of the tumor—the fluid pressure of the blood entering the sac being, according to a well-known law of hydraulics, exerted equally in all directions. This pulsation is most marked when the mouth of the sac is large, and when the sac contains but a small quantity of laminated clot—the pulsation of a partially consolidated aneurism, if at all perceptible, being comparatively obscure, and sometimes scarcely distinguishable from that transmitted to a solid tumor by a subjacent artery. The characters of the pulsation are rendered less distinct by pressure above, and more distinct by pressure below, the aneurism, or by elevating the part in which the tumor is seated. By firmly compressing the artery above the sac, the pulsation in the latter ceases, and it becomes flaccid; if now the hands be placed on either side of the tumor, and the compression be suddenly removed, the entering blood redistends the sac, with a forcible, expanding beat which is almost pathognomonic.

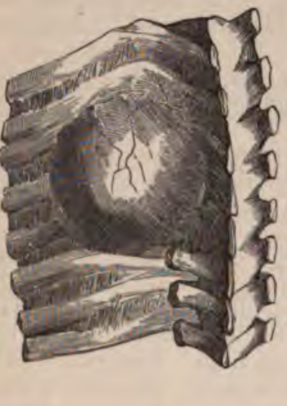
The *pulsation of the artery below the tumor* is sometimes greatly diminished; this is a sign of considerable value in certain cases of intrathoracic aneurism, in which the radial pulse of the affected side may be much weaker than on the sound side, or altogether absent. This, in particular instances, may be due to arterial occlusion from arteritis, to the rigidity produced by calcification, or to external pressure, but, in the majority of cases, is probably owing to the mechanical action of the sac-walls in equalizing the blood current and thus lessening pulsation, just as the air-chamber does in the ordinary "hydraulic ram."

Bruit.—This is the name given to the intermittent *sound* which is heard by applying the ear to an aneurismal tumor, and which is due to the rush of blood from a narrow into a dilated cavity; the *bruit* varies a good deal in different cases, being usually of a rasping or sawing character, and most distinct in tubular aneurisms, and in those with large sac-mouths. It may be scarcely perceptible, or entirely absent, in an aneurism with a very small mouth, or which is nearly filled with laminated coagulum; in cases of femoral or popliteal aneurism, the *bruit* may often be rendered more distinct by causing the patient to lie down, and by elevating the limb. The *bruit*, which is often accompanied with a peculiar *thrill*, is synchronous with the aneurismal pulsation, and ceases with the latter if the artery be compressed above the tumor—returning immediately when the pressure is removed. According to Savory, the *thrill* is most marked when the aneurism projects from the posterior surface of the artery, so that the vessel lies between the sac and the surgeon's hand.

Pressure Effects.—Among the more common pressure effects of aneurism are *venous congestion and œdema*, from compression of the deep-seated *veins*. In some cases a *varicose condition* of the superficial veins may result from the same cause, and *gangrene* may even follow from the obstruction to the returning circulation. The risk of gangrene may be further increased by pressure of the aneurismal sac upon its own or neighboring *arteries*, thus leading to an insufficient vascular supply to more distant parts. Pressure upon *nerves* gives rise to intense *pain*, usually of a lancinating character, and, in certain situations, may lead to serious consequences by interfering with the functions of important parts: thus *hoarseness* and *spasmodic dyspnœa* may result from compression of the recurrent laryngeal nerve, *dyspnœa*, or (as in a case recorded by W. F. Atlee) *uncontrollable eructation*, from pressure on the pneumogastric, and, in cases of intra-cranial aneurism, *facial* *paralysis*, *deafness*, *ptosis*, *strabismus*, or *blindness*, from compression of various cerebral nerves. Pressure upon *secreting glands*, or their *ducts*, may cause trouble by interfering with the functions of the part. Pressure upon *bones and joints* often leads to serious consequences, the flat bones (as the sternum or ribs) becoming eroded and perforated, or caries and disorganization of articulations ensuing, and seriously complicating the treatment of the case. The erosion of bone by the pressure of an aneurismal tumor is often attended by a distressing sensation of burning or boring pain, as in the vertebral column in cases of aneurism of the aorta. Finally, serious consequences may result from pressure on important viscera: thus *dyspnœa* may be due to compression of the *trachea*, *bronchi*, or *lungs*; *dysphagia* to compression of the *œsophagus*; and progressive *emaciation* to pressure on the *thoracic duct*—while *hemiplegia* may result from the compression exercised by an intra-cranial aneurism on the *brain*.

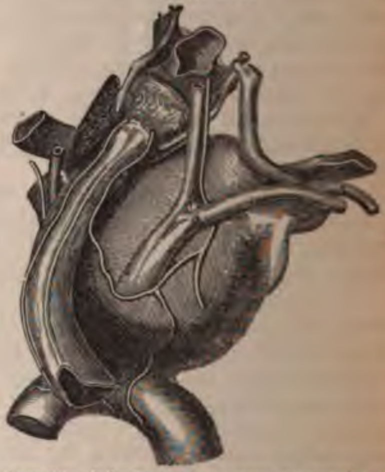
Symptoms of Diffused Aneurism.—When the aneurism becomes diffused by rupture of its sac, the symptoms undergo a certain change. The tumor loses its definition of outline, while it becomes rapidly very much larger; the pulsation, *bruit*, and thrill become faint, or entirely disappear; the part becomes œdematous, and often cold and livid, from venous congestion; the pain is suddenly increased, and syncope may occur; the swelling becomes hard, from coagulation—and, in some rare cases, a boundary of clot and condensed areolar tissue serves to limit the further spread of the disease, which may possibly in these circumstances undergo a spontaneous cure. Usually, however, the swelling continues to increase, with or without pulsation, or evidence of inflammation, and the case ends in gangrene, from conjoined arterial and venous obstruction; or, the clot becoming disintegrated, with suppuration and ultimate giving way of the skin, death follows from external hemorrhage. In some cases, rupture of the aneurismal sac leads to wide extravasation of blood among the tissues of the part, the accident being accompanied with much shock and pain, faintness perhaps resulting from the loss of blood from the general circulation, and gangrene ensuing at no distant period.

FIG. 259.



Ribs perforated by an aortic aneurism. (PIRRIE.)

FIG. 260.



Aneurism of the innominate artery, compressing and stretching the recurrent laryngeal nerve, and pushing the trachea to the left side. (ERICHSEN.)

Diagnosis.—The affections with which aneurism is most likely to be confounded are various forms of tumor, abscess, and simple arterial dilatation. Internal aneurism may be mistaken for rheumatism or neuralgia, but if the disease be situated externally, such an error could scarcely be made, except from want of care in the examination of the case.

From *Pulsating Tumors* of a vascular or encephaloid nature, aneurism may usually be distinguished by its more circumscribed form, its more forcible and distinct pulsation (which is of a peculiar eccentric character), its louder, deeper and more defined *bruit*, and its situation in the course of a large artery. If, however, a vascular or encephaloid growth occur in a locality in which aneurism is common, as in the popliteal space, the diagnosis may become extremely difficult—and the most experienced and careful surgeons have, under these circumstances, occasionally been led into error.

Cysts, or Solid Tumors, seated over an artery, may have a *pulsation* communicated from the latter, and may thus simulate aneurism; the diagnosis may usually be made by observing that the growth can be lifted from, or pushed to one side of, the vessel, when the pulsation will diminish or disappear; that the pulsation itself is not of an eccentric or expansive character; that there is no *bruit*, or at least merely a dull, beating sound, such as may be produced by compressing an artery with a stethoscope; and that the degree of tension of the tumor is not affected by compressing the artery at a point nearer the heart. In some cases, however, a tumor may be connected with several arteries which surround or penetrate its substance, and the diagnosis in such a case might be impossible.

Non-Pulsating Tumors, of a glandular or cancerous nature, may be mistaken for aneurisms in which consolidation has progressed so far as to obscure their pulsation—though the mistake is more apt to be the other way, such an aneurism being taken for a solid tumor. The diagnosis may be sometimes made by observing the mobility of the tumor; thus, by its moving with the larynx in the act of deglutition, a lobular enlargement of the thyroid gland may be distinguished from a carotid aneurism.

Aneurisms have not unfrequently been mistaken for *Abscesses*, and have been hastily opened in consequence; the error may arise from an aneurism becoming diffused, ceasing to pulsate, and exciting inflammation and suppuration in the surrounding tissues, or from the formation of an actual communication between an aneurism and the cavity of an abscess. Errors of diagnosis, under these circumstances, have been made by no less eminent surgeons than Desault, Dupuytren, and Liston. It is probable that, in some of these cases, careful auscultation might reveal a *bruit*, even if all the other signs of aneurism were absent.

General Dilatation of an Artery may simulate aneurism, especially one of the tubular variety; the diagnosis is made by observing the absence of the characteristic symptoms of the latter disease. Under the name of *mimic* or *phantom aneurism*, Sir J. Paget and Dr. S. West have described localized pulsations of arteries which simulate aneurisms, but are not persistent.

For illustrations of the difficulty of diagnosis in cases of aneurism, the student may advantageously consult several papers by Dr. Stephen Smith, of New York, in the *American Journal of the Medical Sciences* for April and October, 1873, and January, 1874.

Terminations of Aneurism.—An untreated aneurism may terminate in a spontaneous cure, or may cause death by pressure on important parts, by inducing syncope, by rupture and consequent hemorrhage, or by causing gangrene.

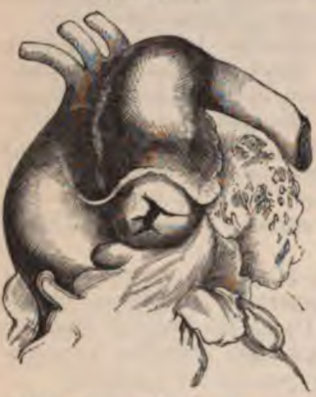
1. Spontaneous Cure.—This, which is unfortunately a rare termination, may be effected in several ways; and it is to be observed that the modes of treatment which will be presently discussed are but imitations of nature's methods of effecting a cure.

(1.) *Gradual Consolidation by Deposit of Laminated Coagulum.*—This is the most frequent mode of spontaneous cure, and is seen almost exclusively in sacculated aneurisms and those occurring in arteries of the second or less magnitude. A case, however, occurred to Stanley, in which an aortic aneurism was spontaneously cured in this way. The sac of the aneurism, acting as a diverticulum, allows contraction of the artery below, which, together with the enlargement of the collateral branches given off above, tends to lessen the force of the current through the aneurism, and thus to encourage the separation of fibrin and consequent formation of the laminated clot. This mode of cure is imitated in the *medical treatment* of aneurism, as well as in the *surgical treatment* by compression on the cardiac side of the sac, by flexion, by the Hunterian mode of ligation, and to a certain extent by Wardrop's operation. A modification of this mode of spontaneous cure is that which is said to occur from the compression of the artery by the aneurism itself, or by another aneurism or solid tumor.

(2.) *Occlusion of the Artery below or above the Sac by Means of a Fibrinous Plug.*—This mode of spontaneous cure is occasionally seen; the artery below the sac may be plugged by the detachment of a fragment of the laminated clot; or, possibly, the artery above the sac, by a similar fragment derived from the heart or a higher aneurism. The former occurrence is imitated in the treatment by manipulation and in Brasdor's operation, and the latter in Anel's method.

(3.) *Inflammation of the Sac* may possibly cause coagulation, and consequent cure of the aneurism, though the soft clot formed in this way is more apt to become subsequently disintegrated, leading to suppuration and rupture of the sac. This mode of cure is imitated by the use of direct pressure, galvano-puncture, the injection of coagulating fluids, etc.

FIG. 261.



Stellate rupture of an aortic aneurism into the pericardium. (ERICHSEN.)

(4.) Finally, a spontaneous cure may, perhaps, occasionally result from *Suppuration and Gangrene*, leading to the extrusion of the aneurismal sac as a slough, while hemorrhage is prevented by the occlusion of the artery by inflammation. This mode of cure is imitated in what is called the "old operation," or that of Antyllus, which is practically equivalent to an excision of the sac.

The evidence of the occurrence of a spontaneous cure consists in the more or less gradual disappearance of the aneurismal pulsation and *bruit*, the sac at the same time becoming firm and contracted, and the circulation being carried on by means of collateral branches.

2. Modes of Death.—An aneurism may prove fatal by (1) *pressure on important parts*, as the phrenic or pneumogastric nerve, the trachea, heart, or lungs; (2) *syncope*, which may occur from a large aneurism becoming suddenly diffused, and is sometimes the immediate cause of death in cases of aortic aneurism; (3) *rupture of the sac and hemorrhage*—which may be in-

ternal, into the brain or spinal canal, pleura, pericardium, trachea, œsophagus or abdominal cavity—or *external*, as when an aortic aneurism perforates the sternum and bursts upon the surface of the body; and (4) *gangrene*, which is apt to occur when an external aneurism becomes diffused, and which is usually complicated with hemorrhage.

The rupture of an aneurism on the *cutaneous* surface is commonly effected by the occurrence of suppuration and pointing, with the formation of a small slough, as in an abscess; on a *mucous* surface, by the occurrence of a small circular ulcer; and on a *serous* surface, by the formation of a fissured or star-like opening.

TREATMENT OF ANEURISM.

This may be conveniently divided into the *medical* or *non-operative*, and the *surgical* or *operative*, treatment of aneurism. The former is the only mode generally applicable to aneurisms of the thoracic aorta, and is the safer mode in certain other cases—while it may be used as a valuable adjuvant to the surgical treatment of aneurism in any situation whatever.

Medical Treatment.—This aims to promote the cure, or at least retard the progress, of aneurism, by inducing, if possible, a deposit in the sac of laminated, fibrinous coagulum. To effect this, the patient should, in the first place, be kept at perfect *rest*—in bed, if possible—and should limit his *diet*, particularly avoiding irritating or indigestible food, stimulants, and large quantities of liquid. The treatment by position and restricted diet has been very successful in the hands of the Irish surgeons, particularly Bellingham and Jolliffe Tufnell. *Small but repeated bleedings* were highly commended by Valsalva, and form a prominent feature of the method of treatment which bears his name. They have likewise been employed with success by Pelletan, Hodgson, and others. Venesection has also been advantageously resorted to by Porter, Broadbent, and others, for the relief of dyspnœa, in cases in which this has been a troublesome symptom. Holmes has suggested the withdrawal of blood directly from the aneurism by means of an aspirator; but the plan seems to me a very unsafe substitute for venesection, and I have heard of one case in which it was the immediate cause of death. Various drugs have acquired a certain reputation in the treatment of aneurism, especially the *acetate of lead* and the *iodide of potassium*, which is very highly spoken of by Balfour, of Edinburgh. Speir, of Brooklyn, recommends the employment of *gallic acid* and the *subsulphate of iron*, and F. Flint, the administration of *chloride of barium*. *Digitalis*, *veratrum viride*, and *aconite* have also been used with advantage, while Langenbeck, Dutoit, Plagge, and others, have lately employed with success hypodermic injections of *ergotine*. The local application of *ice* has been of use in some cases, but is a dangerous remedy, having, according to Broca, induced gangrene of the skin. The pain of a growing aneurism may sometimes be relieved by the use of *anodyne plasters* or *embrocations*, while a *hemlock* or *lead plaster* may be used to give external support in a case in which rupture of an aneurism is impending.

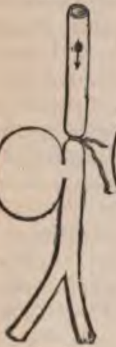
Surgical Treatment.—This embraces a number of different methods which may be considered in succession.

I. **Ligation.**—Ligation may be employed on *both sides* of the aneurismal sac, constituting what is known as the "*Old Operation;*" on the *Cardiac Side*, as in Hunter's and Anel's methods; and on the *Distal Side*, as in the plans of Brasdor and Wardrop.

1. The "Old Operation."—This, which until the early part of the last century, was, with the exception of amputation, the only operation employed in the treatment of aneurism, is also spoken of as the Antyllian method, from Antyllus, who was one of the first, if not the first, to employ it. It consists in opening the sac, and applying ligatures above and below, as was directed in speaking of *traumatic aneurism* (see page 197), though it would appear that by the older surgeons the ligatures were sometimes applied first, and the sac subsequently laid open, or even totally excised. The operation is often a very severe one, and is more liable to be followed by hemorrhage than the Hunterian operation, on account of the artery being tied in immediate proximity to the sac, and where, therefore, it may probably be diseased. In certain situations, however, as in the axilla, root of the neck, or gluteal region, this operation may be sometimes properly employed, and was, under such circumstances, several times resorted to by the late Prof. Syme, with the most brilliant and gratifying success; it may also be practised in cases of diffused femoral aneurism, as a substitute for amputation; and in any locality, if an aneurism have burst or have been accidentally laid open, it may often be the most eligible mode of treatment. A modification of this method, attributed to Guattani, and recently revived by Watson, of Jersey City, consists in plugging the sac, and, if possible, the opening of the artery from which it arises.

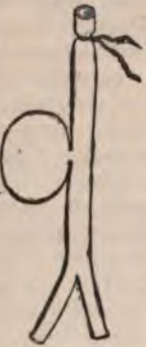
2. Ligation on the Cardiac Side of the Tumor.—The method of ligating an artery for aneurism which, when practicable, is now employed in preference to any other, is that known as the *Hunterian Method* (Fig. 263), from the illustrious John Hunter, by whom it was first resorted to in 1785. In this operation, the vessel is tied *at a distance from the sac* (which is not opened), thus securing a healthy portion of the artery for the application of the ligature, and still allowing a certain amount of blood to pass through the sac by means of the collateral circulation; the cure is thus effected by the deposition of laminated coagulum, and not by the sudden clotting of the whole contents of the tumor. *Anel's Method* (Fig. 262), which is spoken of by most French writers as identical with Hunter's, consists in the application of a proximal ligature *immediately above the sac:* it was employed by Anel in 1710, in a case of traumatic aneurism of the brachial artery, and apparently as a mere experimental variation upon the old method.[1] It does not seem to have been repeated, except once by Desault, and fell into oblivion until after the promulgation of Hunter's plan of operation. Anel's method is defective in not allowing any current through the sac, except from the distal end—imperfect coagulation and suppuration being therefore apt to follow—and in requiring the ligature to be applied to a part of the vessel which is very liable to be diseased, thus exposing the patient to a considerable risk of hemorrhage; the operation is, moreover, difficult, on account of the displacement of the artery by the tumor, and not free from danger. In performing the *Hunterian operation*, those precautions are to be observed

FIG. 262.



Anel's operation.

FIG. 263.



Hunter's operation.

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[1] Keyslère subsequently (in 1774) modified the old operation by substituting *compression* for the distal ligature, retaining, however, the incision of the sac (Pelletan, *Clinique Chirurgicale*, t. i. p. 144).

which were mentioned when speaking of ligation in the continuity of arteries (page 188); before tightening the ligature, it is well to make distal compression for a few seconds, so as to insure the distention of the sac.

The immediate effect of deligation is to arrest the aneurismal pulsation and *bruit*, the limb below the ligature rising in temperature,[1] and often becoming painful and hyperæsthetic; loss of muscular power is also occasionally met with. The consolidation of the aneurism usually begins at once, and in favorable cases is commonly completed in the course of a few days—the tumor gradually contracting subsequently, though it often remains quite perceptible to the touch for weeks or even months. The establishment of the *collateral circulation*, after the Hunterian operation, usually requires the enlargement of two sets of anastomosing vessels—one around the seat of ligation, and another around the aneurism itself—unless in the rare cases in which the sac becomes obliterated, still leaving a channel for the normal flow of blood. If, however, the artery be tied near the sac, as in aneurism of the primitive carotid or external iliac—or in any case by Anel's method—but one set of collateral vessels is needed. If the collateral circulation above the sac be too rapidly established, the operation may fail, the pulsation of the aneurism being renewed as forcibly as at first; in most cases, however, enough coagulation takes place while the circulation is temporarily arrested to insure the continuance of the clotting process, and the attainment of ultimate success. When two sets of collateral branches are enlarged, the lower arch of anastomosis is commonly first developed, owing to the aneurismal swelling itself having led to previous dilatation of the neighboring vessels. If the lower anastomosis be defective, consolidation of the tumor may not take place, and suppuration of the sac, or even gangrene, may follow.

Causes of Failure after the Hunterian Operation.—There are several circumstances which may lead to failure after the Hunterian method of ligation; these are, (1) hemorrhage from the point of ligature, (2) return of pulsation from too free development of the upper collateral circulation—that above the sac, (3) suppuration and sloughing of the sac, often accompanied by hemorrhage, and (4) gangrene of the limb from the combined influence of arterial occlusion and venous congestion.

(1.) *Secondary Hemorrhage from the Point of Deligation.*—This (which, according to Crisp, usually occurs from the seventh to the fifteenth day) is more frequent in the upper than in the lower extremity, on account of the greater freedom of arterial anastomosis in the former situation, but is apt to occur in any locality in which large branches are given off in close proximity to the point of ligation—the clots, upon which arterial occlusion after the use of the ligature depends, being, under such circumstances, insufficient to resist the force of the circulation. In order to diminish the risk of hemorrhage, Holmes recommends the employment of *carbolized catgut ligatures*, and reports a case in which he thus secured the carotid and subclavian arteries, the patient dying from other causes, and the autopsy showing that both vessels had been successfully occluded. Callender, however, from a series of experiments made with catgut ligatures, concludes that they disappear so rapidly (in 50 to 60 hours) in the fluids of a wound as not to give time for the firm occlusion of the vessel, and cases of secondary hemorrhage after the use of carbolized catgut have been reported by the same writer and by Mr. Holden and Dr. Humphry. My own experience in this direction is limited to two cases in which I tied (successfully as regarded recovery from the operation) the common carotid artery for aneurism; as the external coat of the vessel is not divided, I do not see why there should be any special risk of hemorrhage from the disappearance of the ligature, though failure may occur from the artery remaining pervious and thus permitting a return of the blood-current, as indeed actually happened in one of my cases and in others recorded by Heath, T. Smith, Treves, and McCarthy.

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[1] This statement is in accordance with the result of my own observation, and corresponds with the doctrine of Holmes; most writers, however, teach that the temperature at first falls, and subsequently rises when the collateral circulation is established. But, according to Broca, as quoted by Holmes, this rise of temperature does not take place in animals, although in these the collateral circulation is most rapidly established. The increased temperature is apparently due to capillary congestion, caused by the sudden removal of the *vis a tergo* of the heart's action, aided, perhaps, by a positive dilatation of the capillaries, brought about through the agency of the nervous system.

The *treatment* of hemorrhage from the point of ligation, in a case of aneurism, is the same as for bleeding after ligation in the continuity of an artery in any other case, and is to be conducted as directed at page 196.

(2.) *Recurrent Pulsation* is met with when the upper anastomotic arch allows an unusually free flow of blood into the artery, between the sac and point of ligation, and is proportionally most frequent in cases of carotid aneurism, for in these the circle of Willis allows the collateral circulation to be very quickly established. In many cases the recurrent pulsation consists of a mere thrill, without any *bruit;* but it is occasionally as distinct as before the operation. It usually occurs within twenty-four hours after the tightening of the ligature, though sometimes not for four or six weeks, and more rarely at an intermediate period. The prognosis of these cases is usually favorable, the pulsation again disappearing as consolidation is completed—though occasionally a fatal result ensues from suppuration and sloughing of the sac. Pulsation sometimes recurs several months after the consolidation and contraction of the aneurismal tumor, and the case is then properly called one of *secondary aneurism,* though it is probable that in most instances the new tumor is developed at a slightly higher point of the artery than the seat of original disease. Enlargement of the sac after ligation, *without pulsation,* is due to the reflux of blood from the artery on the distal side. If excessive, it may lead to serious consequences—inducing gangrene, by obstructing the venous circulation. Usually, however, as pointed out by Pemberton, coagulation occurs, and the aneurism is thus converted into a solid, fibrinous tumor.

Treatment.—Before tightening the ligature, in an operation for aneurism, the surgeon should ascertain, by pressure with the finger, that doing so will entirely arrest the pulsation in the sac. By neglect of this precaution, the aneurismal current might be kept up by means of a *vas aberrans* or unusual arterial distribution, and the success of the operation might be in consequence prevented. The treatment of recurrent pulsation may usually be satisfactorily conducted by elevating the limb, making moderate compression upon the sac, and perhaps cautiously applying cold. If the pulsation persist, a ligature may be applied lower down, as in Anel's method; but if sloughing of the sac be imminent, the surgeon's only resources will be amputation and the "old operation"—the former being indicated in cases of popliteal or axillary, and the latter in those of cervical or inguinal, aneurism.

(3.) *Suppuration and Sloughing of the Sac.*—This may occur as a consequence of recurrent pulsation—or may result from imperfect development of the lower collateral circulation (preventing consolidation of the tumor), from the size of the sac itself and the thinness of its walls, from the circulation through the sac being completely arrested (leading to coagulation *en masse*, instead of to the deposit of laminated clot), or from external violence, or even careless handling of the tumor before or after operation. The symptoms are those which characterize the occurrence of suppuration in general, the sac finally giving way, and (in about twenty-five per cent. of the cases in which this accident happens) death resulting from hemorrhage. Bleeding is particularly apt to occur in those cases which have been marked by recurrent pulsation, and then follows immediately upon the giving way of the sac; in other cases it may not occur for several days; while if suppuration takes place at a late period, the arteries communicating with the sac may be sufficiently occluded not to allow any hemorrhage at all. Suppuration of the sac is most common in cases of axillary and inguinal aneurism, though it may occur in other situations.

The *treatment* consists in laying open the sac, evacuating its contents, and promoting healing by granulation, a provisional tourniquet being applied as a matter of precaution: should hemorrhage occur, an attempt must be made to secure the bleeding orifice with a ligature, or by the application of the actual cautery—and, if these fail, amputation should be practised, provided that the situation of the aneurism admits of such a course.

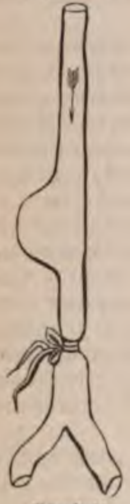
(4.) *Gangrene of the Limb* usually results, as has been mentioned, from the combined effects of arterial occlusion and venous congestion; it is particularly apt to occur in cases of very large or of diffused aneurism, and is predisposed to by loss of blood, by erysipelas, or by the exposure of the limb to undue pressure, cold, or excessive heat. It is most frequent in the lower extremity, and occurs usually from the third to the tenth day, being invariably of the nature of *moist gangrene* from implication of the veins. In order to prevent the occurrence of gangrene, those measures should be adopted which were advised in speaking of *gangrene from arterial occlusion* (page 196); in some cases it may be proper (in order to relieve the venous trunks from pressure) to lay open the sac and evacuate its contents—and, indeed, it is one of the recommendations of the old operation, over that of Hunter, that it is less apt to be followed by mortification. If gangrene have actually occurred, amputation must be performed, usually at the shoulder-joint, in the case of the upper limb, and at the junction of the upper and middle thirds of the thigh, in that of the lower extremity.

Beside the above, which are the common causes of death after ligation for aneurism, there are certain special risks in particular situations. Thus *Cerebral Disease* causes more than one-third of the deaths after ligation of the common carotid (ninety-one out of two hundred and fifty-nine, according to Pilz), and *Intra-thoracic Inflammation* about two-fifths of the deaths after ligation of the third part of the subclavian (ten out of twenty-five, according to Erichsen).

Indications and Contra-indications for Ligation.—The application of the ligature, in the treatment of aneurism, is *indicated* (1) in cases in which the disease is active and advancing, and so situated that, while pressure, flexion, etc., are not applicable, the use of the ligature is not attended with unusual risk, (2) in any case in which less dangerous modes of treatment have been tried and failed, (3) in case an aneurism has burst into an articulation, (4) in case an aneurism has become diffused, and yet not so widely diffused as to require amputation, and (5) in case an aneurism has burst or is about to burst externally, and in case, therefore, the operation is imperatively required to prevent death from hemorrhage. The use of the ligature is, on the other hand, *contra-indicated* (1) by the presence of any complication—such as extensive arterial or cardiac disease, the existence of internal aneurism, old age, or the prevalence of erysipelas—which would probably render the operation peculiarly dangerous, (2) by the locality of the aneurism being such that pressure or flexion would probably be sufficient to effect a cure, as in many aneurisms of the brachial, femoral, and popliteal arteries, and (3) by the locality of the aneurism being such that, from the proximity of anastomosing branches, or from any other cause, the operation would almost certainly terminate unsuccessfully—the imminence of rupture being in such a case the only circumstance that could justify operative interference. *Multiple aneurism* is usually, though not always, a contra-indication; thus, if two aneurisms exist on the same limb, they may both be cured by the same operation;[1] or double popliteal aneurism by ligation of both femoral arteries; in most cases, however, the existence of more than one aneurismal tumor contra-indicates, though it may not positively forbid, ligation.

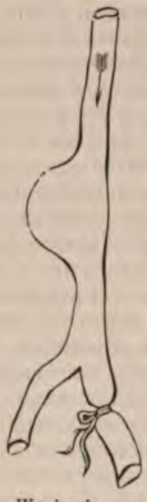
Though I have said that ligation is contra-indicated in many cases of *popliteal* aneurism, yet I believe that in other instances it is the best mode of treatment. The operation, however—which, though delicate, is not in itself very dangerous—should not, of course, be indiscriminately resorted to. If the aneurism be *quite small*, pressure will probably suffice for a cure, and even if it fail, will do little or no harm; and hence, in such a case, should certainly be tried. If, on the other hand, the tumor be *very large*, or if it have become diffused, the risk of gangrene may be so great as to render amputation preferable to either compression or ligation. There is, however, an intermediate set of cases, in which pressure would not be likely to succeed, and in which, if persisted in, it would certainly increase the obstruction to the venous circulation, and thus lessen the chances from subsequent ligation. In such cases, compression should be employed, if at all, with great caution, and ligation should be promptly resorted to, if pressure be not quickly productive of benefit. The surgeon will in this, as in other instances, advance both his own reputation and the interests of his patients, rather by adapting his remedies to the exigencies of each particular case, than by advocating and invariably employing any exclusive mode of treatment.

FIG. 264.



Brasdor's operation.

FIG. 265.



Wardrop's operation.

3. Ligation on the Distal Side of the Tumor.—This operation is attributed to Brasdor, whose name it bears. It was recommended by Desault, but first practised by Deschamps, and subsequently by Wardrop—being indeed often spoken of as Wardrop's method. Though this surgeon, however, successfully employed Brasdor's operation, the plan which he himself suggested, and which properly bears his name, is somewhat different. In *Brasdor's* operation, the whole circulation on the distal side of the sac is arrested—in *Wardrop's* only a part of the distal circulation, by the application of a ligature to a branch of the main trunk, or to one of several arteries proceeding from the aneurism. Thus distal ligature of the carotid for carotid aneurism would be an example of Brasdor's method, but the same operation for innominate aneurism would be properly called Wardrop's. The former aims to produce entire, and the latter partial, arrest of the circulation through the sac. The risks, besides those incident to the Hunterian mode of ligation, are that the sac, being still distended by the cardiac impulse, may continue to increase in size, the operation thus failing, even if suppuration and sloughing do not lead to a fatal termination. Hence, except in particular cases, as of aneurism of the root of the carotid, or of the innominate, the distal ligature is not to be recommended.

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[1] Pemberton has recorded a case in which *three* aneurisms on the same limb were cured by ligation of the external iliac artery.

II. **Acupressure** has been successfully employed in a few cases of aneurism, but does not appear to present any particular advantages over the use of the ligature. Various modifications of this method, under the name of temporary ligature, filopressure, etc., have also been employed by Stokes, Dix, and others, but not often enough to enable us to say whether they will ultimately be found any better than the methods of treatment which have been longer before the profession. (See page 191.)

III. **Compression.**—Compression may be made *directly* upon the aneurism, or *indirectly* upon the artery, at a point *above* or *below* the tumor (*proximal or distal compression*); it may be effected by the hands of the surgeon or his assistants (*digital compression*), or by means of instruments (*instrumental compression*). *Direct Pressure* upon the aneurismal sac was introduced by Bourdelot, in the seventeenth century, and has since been successfully employed, from time to time, by various surgeons, but is so uncertain, and occasionally so dangerous, a method, that it is now generally abandoned as an exclusive mode of treatment—while *Distal Compression*, which was proposed by Vernet, in the last century, failed in its author's own hands, and is rarely employed at the present day, though Varick reports a case of inguinal aneurism in which it effected a cure in connection with rest in bed and the administration of iodide of potassium. Both direct and distal compression may, however, prove valuable adjuvants to pressure on the proximal side of the sac, as in the plan recently adopted by Reid, Wagstaffe, Tyrrell, Sydney Jones, F. A. Heath, Wright, T. Smith, Weir, Freeman, Wheeler, and others, who have cured popliteal aneurisms by pressure with Esmarch's bandage. Stimson has collected 62 cases of aneurism treated in this manner, a successful result having been obtained in 35, while only 2 proved fatal. The treatment of aneurism by *Compression on the Cardiac Side of the Tumor* was employed by Hunter, Blizard, and particularly Freer, in England, and by Pelletan, Dupuytren, and others, in France, but did not attain the position which it now occupies in the estimation of the profession until it was, about thirty years ago, revived and systematized by the Irish school of surgeons, particularly by Hutton, Bellingham, Tufnell, and Carte. It is not necessary, as was formerly supposed, to make such firm pressure upon an artery which is the seat of aneurism as to entirely interrupt the flow of blood—and still less to excite such a degree of inflammation as might lead to the obliteration of the vessel; on the contrary, the object being to imitate nature in her mode of effecting a spontaneous cure, by inducing the gradual deposition of laminæ of fibrinous clot, it is sufficient to exercise enough compression to simply arrest the pulsation of the sac, without preventing the flow of blood through it. This mode of treatment is particularly applicable to sacculated aneurisms, though it may also succeed in cases of the tubular variety, in which, however, the cure is effected rather by the gradual contraction of the aneurismal dilatation, than by the deposit of fibrin. The chances of success by compression are greatest when the sac contains only fluid blood, coagulation in an already partially consolidated aneurism being apt to occur suddenly, and in an imperfect manner. After recovery, the sac is commonly entirely filled up, but in some cases a channel remains, through which the normal circulation is carried on.

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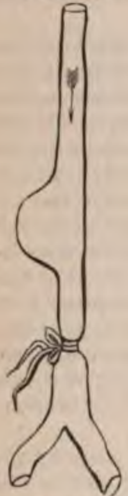
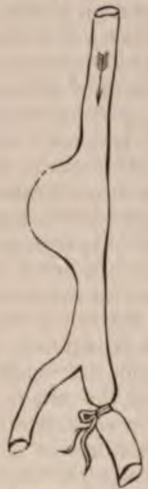


Brasdor's operation.

FIG. 265.



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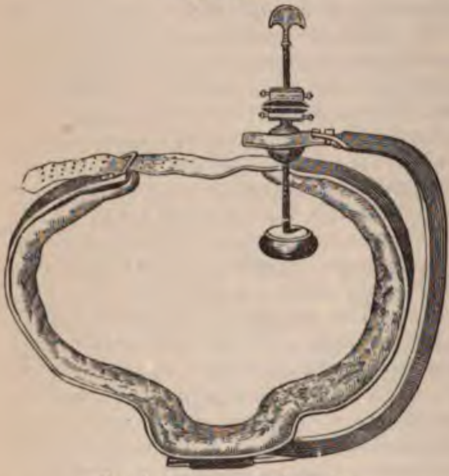
III. **Compression.**—Compression may be made *directly* upon the aneurism, or *indirectly* upon the artery, at a point *above* or *below* the tumor (*proximal* or *distal compression*); it may be effected by the hands of the surgeon or his assistants (*digital compression*), or by means of instruments (*instrumental compression*). *Direct Pressure* upon the aneurismal sac was introduced by Bourdelot, in the seventeenth century, and has since been successfully employed, from time to time, by various surgeons, but is so uncertain, and occasionally so dangerous, a method, that it is now generally abandoned as an exclusive mode of treatment—while *Distal Compression*, which was proposed by Vernet, in the last century, failed in its author's own hands, and is rarely employed at the present day, though Varick reports a case of inguinal aneurism in which it effected a cure in connection with rest in bed and the administration of iodide of potassium. Both direct and distal compression may, however, prove valuable adjuvants to pressure on the proximal side of the sac, as in the plan recently adopted by Reid, Wagstaffe, Tyrrell, Sydney Jones, F. A. Heath, Wright, T. Smith, Weir, Freeman, Wheeler, and others, who have cured popliteal aneurisms by pressure with Esmarch's bandage. Stimson has collected 62 cases of aneurism treated in this manner, a successful result having been obtained in 35, while only 2 proved fatal. The treatment of aneurism by *Compression on the Cardiac Side of the Tumor* was employed by Hunter, Blizard, and particularly Freer, in England, and by Pelletan, Dupuytren, and others, in France, but did not attain the position which it now occupies in the estimation of the profession until it was, about thirty years ago, revived and systematized by the Irish school of surgeons, particularly by Hutton, Bellingham, Tufnell, and Carte. It is not necessary, as was formerly supposed, to make such firm pressure upon an artery which is the seat of aneurism as to entirely interrupt the flow of blood—and still less to excite such a degree of inflammation as might lead to the obliteration of the vessel; on the contrary, the object being to imitate nature in her mode of effecting a spontaneous cure, by inducing the gradual deposition of laminæ of fibrinous clot, it is sufficient to exercise enough compression to simply arrest the pulsation of the sac, without preventing the flow of blood through it. This mode of treatment is particularly applicable to sacculated aneurisms, though it may also succeed in cases of the tubular variety, in which, however, the cure is effected rather by the gradual contraction of the aneurismal dilatation, than by the deposit of fibrin. The chances of success by compression are greatest when the sac contains only fluid blood, coagulation in an already partially consolidated aneurism being apt to occur suddenly, and in an imperfect manner. After recovery, the sac is commonly entirely filled up, but in some cases a channel remains, through which the normal circulation is carried on.

During the treatment by compression, the patient should of course be confined to bed,[1] and the hygienic and other means spoken of under the head of *Medical Treatment* put in force. Nervous irritability and pain should be controlled by the free use of opium, and in certain cases, in which the needful pressure cannot be otherwise borne, ether or chloroform may be administered by inhalation.

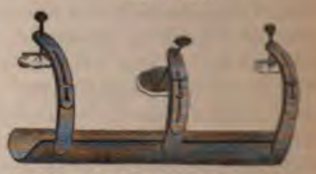
1. Instrumental Compression may be effected by the use of various forms of apparatus, such as a Signoroni's or a Skey's tourniquet (Figs. 26, 27), Lister's compressor (Fig. 28), Reade's or Carte's apparatus (in the latter of which (Fig. 266) elastic force is applied by means of vulcanized India-rubber bands), or a simple conical weight, held in position by means of a leather socket, or, as successfully employed in Bellevue Hospital, New York, a bag of shot suspended from the ceiling.[2] In situations in which a considerable extent of artery can be dealt with (as in the thigh), alternate pressure upon several points may be practised, by means of an instrument such as that represented in Fig. 267, which was modified from one of Charrière's, by Dr. Gibbons, formerly of this city. The points which require special care, in the application of instrumental compression, are to see that the artery is fairly pressed against the bone, while the pressure is not so widely diffused as to cause great venous congestion from implication of the deep-seated veins, and to guard against excoriation of the skin by carefully shaving and powdering the part, and by occasionally changing the point of pressure. In situations in which very deep pressure is necessary to control the circulation, and in which, therefore, the treatment becomes very painful (as in compressing the aorta, common iliac, or subclavian), anæsthesia may be previously induced, as proposed by Murray, and may be steadily kept up for as many hours as may be thought safe.

FIG. 266.



Carte's compressor for the groin.

FIG. 267.



Gibbons's modification of Charriere's compressor.

Rapid Pressure Treatment of Aneurism.—Murray, Heath, Mapother, Levis, Agnew, and other surgeons, have succeeded in curing aneurisms of the iliac and femoral arteries, and even of the abdominal aorta, by completely arresting the flow of blood through the sac by means of instrumental compression, applied above or on both sides of the tumor, and kept up in some cases for many hours, the patient meanwhile being under the influence of an anæsthetic. The mechanism by which the cure is effected in these cases seems to be the coagulation *en masse* of the contents of the aneurismal sac, the mode of treatment being thus assimilated to Anel's and Brasdor's operations. While "the rapid pressure treatment" is unquestionably a valuable addition to the surgeon's means of dealing with aortic and inguinal aneurisms, it can not, in my judgment, replace, in the treatment of aneurisms in other situations, the ordinary mode of making instrumental compression—which aims to effect a cure by inducing a gradual formation of laminated coagulum, and which I believe to be safer, if less brilliant, than the rapid method, which has already led to five fatal results in the hands of British surgeons.

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[1] Dr. Buckminster Brown has, however, reported a case in which direct compression effected a cure while the patient continued to walk about.

[2] Dr. Sawyer, of San Francisco, employs a shot-bag terminating in a distended India-rubber ball, which gives a certain degree of elasticity to the apparatus. Dr. Palmer, of Minnesota, employs a cork held in position with a plaster-of-Paris collar, and applies pressure by surrounding the whole with an India-rubber bandage; a shot-bag, held in place with elastic bands, is employed by Madruzza, of Perugia.

2. **Digital Compression,** which was first proposed by Vanzetti, of Padua, about twenty-five years ago, and which has been successfully resorted to by Knight, of New Haven, Parker and Wood, of New York, S. W. Gross, Agnew, and many others, myself included, may be employed as an exclusive measure of treatment, or as an adjuvant to compression by means of instruments. For its use in the former mode, constant relays of skilled assistants are usually required, and these can frequently not be obtained; hence, though its statistical results are very favorable (the average duration of treatment in successful cases being, according to Gross and Fischer, about three days), it is principally as an aid to instrumental compression that it is likely to be generally resorted to. The employment of digital compression can be much facilitated by Holden's plan of superimposing a weight upon the finger, which can thus keep up the pressure for a considerable length of time without fatigue. The statistics of digital compression have been particularly studied by Fischer, of Hanover, who finds that 188 cases (in all situations) gave 121 successes, and 67 failures. In 17 of the successful, and in 33 of the unsuccessful, cases instrumental compression and other means were also employed. Death occurred in 19 instances, once after digital compression alone (from gangrene), three times after digital and instrumental compression, ten times after subsequent ligation, three times after amputation, and twice after opening the sac. Digital compression is estimated by Fischer to be five per cent. more successful than instrumental compression, and is considered by him superior to any other mode of treatment except flexion, which he thinks should be preferred in any case in which it is applicable.

When it is resolved to attempt the cure of an aneurism by pressure, the patient being prepared as has been directed, and the circulation through the aneurism controlled by the application of a suitable instrument, compression should be steadily maintained, if possible, until consolidation is complete, or at least measurably advanced. This may usually be accomplished by using an instrument such as that of Dr. Gibbons, or by employing digital compression during the intervals in which the pressure of the instrument is relaxed. A cure has, indeed, been obtained in cases in which pressure has occasionally been intermittent for several hours at a time, but it seems probable that, when applicable, *moderate but continuous pressure* is more likely to prove beneficial than that which is more forcible but not steadily maintained.

It is well, before applying compression to the cardiac side, to insure the complete distention of the sac by the use for a few minutes of *distal* compression. The contraction of the aneurismal sac may also be promoted by making gentle direct pressure upon the tumor, during the whole course of treatment, by means of a carefully-applied bandage, the action of which may be aided by Corradi's plan of interposing an air-ball between this and the aneurism.

Advantages and Disadvantages of Compression.—The *advantages* of this mode of treatment are very obvious; it is certainly, though not entirely free from risk, far safer (in most cases) than ligation of the artery, and, in cases in which it proves successful, is not materially more tedious. In many instances, a cure has been effected in from a few hours to three or four days, and the *average duration* of treatment, in successful cases, is, according to Hutchinson's statistics (for popliteal aneurism), about nineteen days, or about the same time as is commonly required for the separation of a ligature from the femoral artery. Its *disadvantages* are that it often fails—124 cases of popliteal aneurism thus treated gave, according to Holmes, only 66 cures—and that when it fails, the chances of subsequent successful deligation are less than they would have been had the latter operation been primarily employed. This fact is, indeed, denied by many surgeons, and it is even claimed that previous compression, by favoring the establishment of the collateral circulation, lessens the chance of gangrene after the use of the ligature; but, as long ago pointed out by Porter, the risk of gangrene after operations for aneurism is more from venous congestion than from arterial deficiency; and that compression tends rather to increase than to diminish venous congestion, will probably not be doubted. Nor is it fair to assert that the long list of failures after compression is entirely due to want of care in its application; for the advocates of the ligature might as justly respond, with the late Mr. Syme, that most of the untoward results of that operation were due to the operator's want of skill—Syme himself, as is well known, having tied the femoral artery thirty-five times, with but a single death.

In what cases, then, should compression be used? The answer should, I think, be somewhat as follows: Compression should be employed, by preference (1) in all cases in which, from the age or general condition of the patient—from the existence of heart disease, of other aneurisms, or of marked structural change of the arterial coats—or from the prevalence of erysipelas, pyæmia, etc., the operation of ligation would be attended by particular risk; (2) in all cases in which the aneurism, being detected at an early stage, would be in the most favorable condition for the use of compression, and in which the pressure treatment, if even it failed, would not seriously lessen the prospect of benefit from subsequent ligation; and (3) in all cases, on the other hand, in which the aneurism, from its locality or size, would not probably be amenable to the ligature, and in which, therefore, pressure should be at least tried before resorting to such formidable measures as amputation or the "old operation."

Finally, compression may be *tentatively* employed in almost every case—even in popliteal aneurisms of moderate size, which are those specially adapted to the use of the ligature. If, however, decided benefit be not obtained in a short time—three or four days,[1] or after a still shorter trial, if venous congestion, œdema, and pain are markedly increased by the treatment—the surgeon should, I think, unhesitatingly abandon compression and resort to the Hunterian operation, which, under such circumstances, I cannot but believe to be a preferable mode of treatment.

IV. **Flexion.**—This mode of treatment was introduced by Mr. Ernest Hart, in 1858,[2] and has since been successfully employed by Shaw, Pemberton, and several other surgeons. Its efficacy depends chiefly upon the interference with the arterial circulation caused by bending the vessel to an acute angle, but is assisted by the direct compression exercised upon the sac by the contiguous surfaces between which it is thus placed. Flexion is applicable in cases of popliteal aneurism, and of aneurism at the bend of the elbow, or in the axilla. Its application is very simple, consisting merely in the retention of the limb in the flexed position by means of a double collar or figure of 8 bandage. If flexion is to be employed by itself, the limb should be bent so as to completely check the aneurismal pulsation. In most cases, however, it is preferable to employ moderate flexion, using it as an adjuvant to digital or to mild instrumental compression. The statistical results of the flexion treatment have been studied by Stapin and by Fischer; the former writer finds that 49 cases gave 26 successes and 23 failures, 11 of the successes having been due to flexion alone, and 15 to this in combination with other methods; while Fischer finds that 57 cases gave 28 successes (20 by flexion alone) and 29 failures.

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[1] Holmes gives a week as the proper limit.

[2] It is said to have been previously employed both by Fergusson and by Maunoir, of Geneva.

It is probable that a combination of flexion with alternate instrumental and digital compression, would be found in many cases as satisfactory as it would be certainly a less irksome mode of treatment than either plan by itself.

V. **Manipulation.**—This method consists in squeezing or kneading the aneurismal sac in such a way as to break up the contained laminated coagulum—a fragment of which it is hoped may plug the artery at the distal side, and thus lead to the consolidation of the tumor. This plan was introduced by Fergusson, and has been successfully employed by Little, Teale, and Blackman, of Cincinnati, having been combined by the last-mentioned surgeons with proximal compression. According to Van Buren, this is the true explanation of the cures reported from the use of Esmarch's bandage, as of many other recoveries attributed to compression alone. The dangers of this mode of treatment are that rupture of the sac and consequent diffusion of the aneurism, or inflammation and gangrene, may be caused by the application of too much force; and that (in cases of subclavian or carotid aneurism, for the former of which Fergusson employed it) a fragment of clot may occlude the carotid or vertebral artery, and thus lead to grave if not fatal cerebral disturbance. Cases are mentioned by Esmarch and Teale in which death followed the occurrence of this accident during the mere preliminary examination of patients suffering from carotid aneurism, and Tillaux has recently recorded a case of paralysis and aphasia resulting from embolism similarly occurring during the examination of an aortic aneurism.

VI. **Galvano-puncture** was first employed by B. Phillips in 1838, and has since been resorted to in a number of cases of aneurism by Pétrequin, Ciniselli, Duncan, Althaus, and others. Both poles of the battery should, as a rule, be introduced into the sac. The great risks of the operation are that coagulation *en masse* will probably occur, and that sloughing of the aneurismal wall may take place at the points of puncture—an accident which would be apt to be followed by hemorrhage. Embolism of the carotid proved fatal in a case referred to by Wheelhouse. The statistics of this mode of treatment are not very favorable; 89 cases collected by Duncan gave 12 deaths, and only 31 recoveries, while Petit's collection of 114 cases gives 38 deaths, and only 69 recoveries, many of these, too, not having been permanent. The only cases, therefore, to which galvano-puncture seems appropriate are such as forbid either compression or ligation, and yet require active treatment. Guimaraez has reported a case of carotid aneurism cured by the *external* application of electricity.

VII. **Injections of Coagulating Liquids,** and especially of the *perchloride of iron*, have been practised upon several occasions, and sometimes with success. This is, however, a very dangerous method of treatment (the principal risks being from inflammation, gangrene, rupture, and embolism), and its use is rarely justifiable except in localities in which both cardiac and distal compression can be maintained until coagulation is complete—in localities, in fact, in which either compression or ligation would be equally applicable, and certainly preferable.

VIII. **Acupuncture,** and the **Introduction of Foreign Bodies,** such as *fine wire* (Moore, Domville, Murray), *watch-spring* (Montenovesi and Bacelli), *horsehair* (Levis, Maury, Stimson), and *catgut* (Bryant), have been tried—each aiming to effect a cure by furnishing a starting-point for coagulation; acupuncture, in conjunction with proximal compression, proved successful in a case of ilio-femoral aneurism reported by Dr. William Macewen, but the introduction of foreign bodies has proved utterly useless in every case in which it has thus far been employed.[1]

IX. **Strangulation** has been successfully employed for very small aneurisms, two needles or harelip pins being passed beneath the tumor, and a ligature thrown around their extremities, as in cases of nævus.

X. **Caustic** has likewise been used with success as an application to very small aneurisms.

XI. **Amputation.**—Finally, amputation would be required, if an aneurism in a limb should become diffused and threaten gangrene, if the pressure of the tumor should cause extensive caries of the neighboring bone, or if hemorrhage should occur from external rupture. Amputation may also be required in the event of the failure of ligation.

Arterio-Venous Aneurism.—As the result of ulcerative action, a preternatural communication may occasionally be formed between an artery and a contiguous vein, constituting a non-traumatic variety of *aneurismal varix.* The symptoms and treatment do not differ from those of the traumatic form of the disease, which has been already described (see page 198).

TREATMENT OF PARTICULAR ANEURISMS.

From a consideration of the principles laid down in the preceding pages, and from an examination of the statistical results, as far as they can be ascertained, of various modes of treatment, we may arrive at the following conclusions as to the best course to be adopted in dealing with aneurismal disease in various parts of the body.

Thoracic Aorta.—Permanent benefit can seldom be hoped for from operative treatment in aneurism of the aortic arch. Ligation on the cardiac side of the sac is evidently out of the question, and hence the choice as regards operations is limited to tying the carotid alone (and, unless the innominate be also involved, the *left* carotid is, as pointed out by Dr. Cockle, the one to be chosen), or to tying this and the subclavian artery as well. The former plan has been adopted in thirteen cases, and the latter in eleven, temporary relief having been afforded in several of each category; the most successful operations have been those of Mr. Heath, one of whose patients lived four and a half years after ligation of the carotid only, and another four years after the simultaneous ligation of the carotid and third part of the subclavian.[2]

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[1] Dr. Horace Dobell recommends the injection of *melted spermaceti.*

[2] In another case, however, Mr. Heath failed in attempting the same operation, on account of the aneurism extending much further than had been anticipated. This patient died.

Still less success has attended the treatment by coagulating injections, and that by the introduction of a coil of wire or watch-spring, which was first tried by the late C. H. Moore, and which has been more recently employed by Domville and Murray, and in two cases by Bacelli; no benefit resulted to the patient in Domville's case, while the other four all terminated fatally, as did the case in which the introduction of horsehair was tried by Maury, of this city. Distal pressure proved of benefit in cases recorded by Dr. Lyon and Mr. Edwards, and referred to in Mr. Heath's pamphlet, as did galvano-puncture in 13 out of 36 cases referred to by Dr. Bowditch, of Boston, and in 69 out of 114 cases collected by Petit. The only treatment, however, to be ordinarily recommended, in a case recognized as aneurism of the thoracic aorta, is the medical and hygienic treatment, described at page 553.

Cases of Aortic Aneurism treated by Ligation of Carotid Artery.

No.	Operator.	Result.	Remarks.
1	Tillanus,	Relieved.	Died suddenly, five months subsequently.
2	Rigen,	Relieved.	Died in three months, from strangulated hernia.
3	Montgomery,	. . . . .	Died in four months; sac suppurated.
4	O'Shaughnessy,	Died.	Died in seven days; galvano-puncture also used.
5	Knowles,	"	Died of apoplexy.
6	Heath,	Relieved.	Died 4½ years afterwards, from external rupture.
7	Annandale,	Relieved.	Tumor still pulsated.
8	Holmes,	Relieved.	Doing well eighteen months after operation.
9	Callender,	. . . . .	Died in twelve months.
10	Bryant,	Died.	Died in ten days; pyæmia; no clot in sac.
11	Barwell,	. . . . .	Wound healed.
12	Ashhurst,	Relieved.	Died in seven weeks, from suffocation.
13	Kuester,	Died.	Right carotid tied; died in forty hours.

Cases of Aortic Aneurism treated by Ligation of both Carotid and Subclavian Arteries.

No.	Operator.	Result.	Remarks.
1	Hobart,	Died.	Subclavian tied in *first* portion; hemorrhage from *carotid* on sixteenth day.
2	Heath,	Relieved.	Life prolonged for four years.
3	Maunder,	Died.	Died on sixth day, from occlusion of aorta.
4	Sands,	Relieved.	Hemorrhage from *carotid* on 43d and 48th days, checked by pressure; not much benefit from operation. Death thirteen months afterwards.
5	Maury,	Died.	Ligatures came away without bleeding; aneurism grew with increased rapidity. Introduction of horsehair tried. Death from external rupture of aneurism.
6	Speir,	Died.	Carotid constricted with artery constrictor; two days afterwards, subclavian tied; no hemorrhage from either wound, but death on 34th day from external rupture.
7	Barwell,	Relieved.	Died fifteen months afterwards.
8	Kuester,	Relieved.	Carotid tied first, and subclavian some months afterwards.
9	Lediard,	Relieved.	Patient living seven months after operation.
10	Pollock,	Died.	Died in ten days.
11	Wyeth,	Relieved.	Doing well ten weeks after operation.

Innominate Artery.—The chief operative treatment applicable to innominate aneurism is the distal ligature, applied to the carotid, to the subclavian or axillary, or to both vessels, consecutively or at the same time. The carotid alone appears to have been tied for innominate aneurism twenty-four times, with six more or less permanent recoveries, and eighteen deaths. The subclavian or axillary alone has been tied five times, with at least temporary benefit in three instances. The double ligature has been employed in twenty-eight cases, the arteries having been tied consecutively in five, and simultaneously in twenty-three, only one of the former category and six of the latter proving permanently successful. In four cases which have been already referred to (Hobarth's, Heath's, Maunder's, and Sands's), the aneurism was eventually found to have been aortic, while in Cuvillier's case (which was likewise supposed to be one of innominate aneurism) the affected artery was found after death to have been the subclavian. Hodges, of Boston, employed the double simultaneous ligature in a case of supposed innominate or aortic aneurism, but after the death of the patient, which occurred on the eleventh day, no aneurism at all was found, though both vessels were dilated; and in a similar case referred to by Stimson as having been operated upon by Doughty and A. B. Mott, by consecutive ligation, when the patient died three years afterwards, the aorta alone was found dilated.[1] On the other hand, Cheever, of Boston, in a case of innominate aneurism made an unsuccessful attempt to apply the double ligature; the position of the carotid artery could not be detected, and, in endeavoring to secure the subclavian artery, the accompanying vein was ruptured, death following in two hours. It is thus seen that, as far as statistics bear upon the question, the advantage is, upon the whole, with ligation of either vessel alone; hence, if the ligature is to be used at all, that artery should be first tied in the direction of which the aneurism appears to be chiefly disposed to spread, the ligation of the other vessel being reserved for a subsequent occasion, if it should be found necessary; as to the part of the subclavian to which the ligature should be applied, I would decidedly recommend the third portion, or that beyond the scaleni; though it is but right to add that Mr. Holmes is disposed to think that, by employing a ligature of carbolized catgut, the risk of hemorrhage would be so much lessened[2] that the question of tying the first portion of the artery might properly be entertained. But as the operative treatment by any plan is so unsatisfactory, a fair trial should always be first given to the effect of rest and medical treatment, aided, perhaps, by distal pressure, which proved of benefit in a case under the care of Mr. Syme. In a case of Luke's, repeated bleedings and the use of digitalis effected a cure, while Coote obtained an equally happy result by the enforcement of rest and the application of ice.

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[1] Wyeth, however, believes that there was an aneurism of the innominate in this case, and that it was cured by the operation.

[2] The use of carbolized catgut has, however, been followed by secondary hemorrhage in cases of ligation of the femoral artery recorded by Mr. Holden, Mr. Callender, and Dr. Humphry.

Cases of Innominate Aneurism treated by Ligation of Carotid Artery.

No.	Operator.	Result.	Remarks.
1	Evans,	Recovered.	Lived twenty-eight years subsequently.
2	Mott,	Relieved.	Died seven months subsequently, from asphyxia.
3	Mott,	Died.	Death from hemorrhage in three weeks.
4	Key,	"	Died in a few hours.
5	Morrison,	Recovered.	Lived twenty months subsequently.
6	Fergusson,	Died.	Died on seventh day, from pneumonia.
7	Hutton,	"	Died on sixty-sixth day; suppuration of sac.
8	Campbell,	"	Died on nineteenth day, from pneumonia.
9	Wright,	"	Died on sixtieth day; hemiplegia.
10	Broadbent,	"	Died in fourth month, from hemorrhage.
11	Hewson,	"	Died on eleventh day.
12	Neumeister,	"	Died on fifth day; hemiplegia.
13	Scott,	"	Died from rupture of sac.
14	Dohlhoff,	"	Died on sixth day; paralysis.
15	Porta,	"	Died in forty hours, from erysipelas.
16	Villardebo,[1]	"	Died on twenty-first day, from hemorrhage.
17	Ordile,	"	
18	Pirogoff,	Relieved.	
19	Pirogoff,	"	
20	Pirogoff,	Died.	Hemiplegia.
21	Nussbaum,	"	Died from rupture of sac.
22	Nussbaum,	"	Died from rupture of sac.
23	Heath,	"	Mistaken for aortic aneurism, and *left* carotid tied. Death almost immediately, from anæmia of brain.
24	Desgranges,	Relieved.	Died twelve months subsequently, from independent causes.

Cases of Innominate Aneurism treated by Ligation of Subclavian or Axillary Artery.[2]

No.	Operator.	Result.	Remarks.
1	Wardrop,	Relieved.	Died two years subsequently, from dropsy.
2	Laugier,	Died.	Died in a month, from asphyxia (axillary tied).
3	Broca,	Relieved.	Died in six months, from gangrene of lung.
4	Blackman,	Died.	Died in eight days, from hemorrhage.
5	Bryant,	Relieved.	Improvement continued at last report.

Cases of Innominate Aneurism treated by Consecutive Ligation of Carotid and Subclavian Arteries.

No.	Operator.	Result.	Remarks.
1	Fearn,	Recovered.	Died from causes unconnected with operation.
2	Wickham,	Died.	Died in two and a half months; rupture of sac.
3	Malgaigne,	"	Died on twenty-first day, from erysipelas.
4	Bickersteth,	"	Died in three months.
5	J. Adams and F. Treves,	Relieved.	Died in three months.

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[1] This appears to be identical with the case attributed to Rompani. Erichsen mentions other unsuccesful cases attributed to Knowles and O'Shaughnessy.

[2] Dupuytren's case, usually placed in this category, was one of subclavian aneurism.

Cases of Innominate Aneurism treated by Simultaneous Ligation of Carotid and Subclavian Arteries.

No.	Operator.	Result.	Remarks.
1	Rossi,	Died.	Died in six days.
2	Hutchison,	"	Died in forty-one days; some doubt as to whether the subclavian was really tied.
3	J. Lane,	"	Rupture of sac.
4	McCarthy,	"	
5	Durham,	"	Died on sixth day, from shock.
6	Holmes,	"	Died in eight weeks; galvano-puncture also used.
7	Ensor,	"	Died in nine weeks.
8	Weir,	"	Died in fifteen days; rupture into trachea.
9	Barwell,	Recovered.	Died subsequently, from bronchitis; aorta also involved.
10	Kelburne King,	Relieved.	Temporarily relieved; died in 111 days, from hemorrhage; aorta also involved.
11	Eliot,	Died.	Died on twenty-fifth day, from hemorrhage.
12	Barwell (2d case),	Recovered.	
13	Id. (3d case),	"	
14	Id. (4th case),	Died.	Died in thirty hours, from effects of anæsthetic.
15	Stimson,	Recovered.	Died 21 months afterwards, from phthisis.
16	Palmer,	Relieved.	Died, after four months.
17	Denucé,	No benefit.	Wounds healed, but no change in tumor.
18	Ransohoff,	Died.	Death on seventh day.
19	King (of Hull),	Relieved.	Doing well two months afterwards.
20	Howard Marsh,	?	
21	Pollock,	Died.	Died in eight days.
22	H. W. L. Browne,	Recovered.	
23	J. L. Little,	"	Death from pleurisy, three years and four months after operation.

Carotid Artery and Branches.—Carotid aneurism is usually looked upon as specially adapted for the treatment by ligation. The operation of tying the common carotid is, however, attended in itself by very considerable risk—the mortality being, according to Norris's statistics, over thirty-six per cent., and according to those of Pilz, over forty-three per cent.[1] Of 84 cases in which the common carotid was tied during our late war, no less than 63 (75 per cent.) terminated fatally, and 101 cases collected by Mr. Maunder, of ligation for wound or traumatic aneurism, gave but 34 recoveries. I have myself tied the common carotid in three cases, and each time successfully, as regarded recovery from the operation. As more than one-third (ninety-one out of two hundred and fifty-nine) of the deaths after this operation have resulted from cerebral disease due to the interference with the circulation of the brain, it is evident that in any case in which it is practicable to do so, ligation of the external should be substituted for that of the common carotid. If, however, as is usually the case, the aneurism involves the common trunk itself, and pressure proves unavailing, ligation of the primitive carotid must be resorted to. Ligation by the Hunterian method has, according to Pilz, been done in eighty-seven cases, with fifty-five known recoveries and thirty-one deaths, the result of one case not having been ascertained. For *traumatic* aneurism at the *root* of the carotid, the surgeon may choose between Brasdor's and the "old operation," which has been successfully employed by Syme and Frothingham. For *non-traumatic* aneurism the "old operation" would be unsuitable, for the surgeon could not be absolutely sure that the disease might not involve the innominate, or even the aorta; and hence, in such a case, the distal ligature (first practised by Wardrop) is the plan of treatment most to be recommended. Of nine patients on whom this operation has been performed, four recovered (Wardrop, Bush, Colson, Wood), two were relieved (Wardrop, Delens), and three died (Lambert, Demmé, Lane)—a sufficiently favorable record to encourage a resort to the operation under suitable circumstances.[1]

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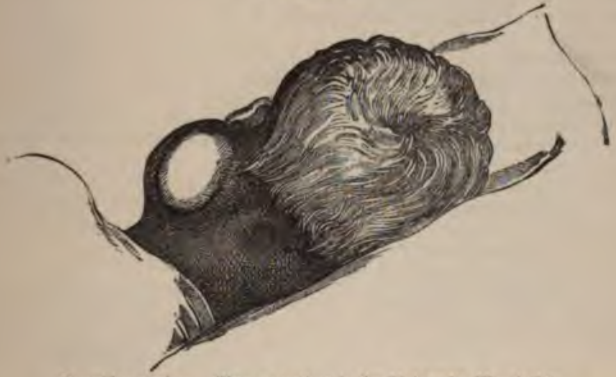
[1] Both carotids have been tied in twenty-seven cases—once simultaneously (fatal in twenty-four hours), and twenty-six times with greater or less interval between the operation; only five of the latter cases proved fatal.

FIG. 268.



Carotid aneurism. (From a patient in the University Hospital.)

Internal Carotid and Branches.—Aneurisms of the internal carotid and its branches, including *intra-cranial* and *intra-orbital* aneurisms, may require ligation of the common carotid artery, though digital compression with medical treatment should always be first tried in these cases. The results of carotid ligation for intra-orbital aneurism are quite favorable, twenty-nine cases, collected by Noyes, having given twenty-five recoveries and but one death, and sixty-four cases quoted by Wolfe, from Sattler, having given forty recoveries, ten failures, and fourteen deaths.

The *internal carotid artery* has been successfully tied in cases of *hemorrhage* by Keith, Buck, Briggs, Sands, S. Smith, A. T. Lee, and Barba, but does not appear to have been tied in cases of aneurism. Bramlette's and Byrd's cases, in which the common carotid was tied with both its branches, have already been referred to (page 200).

Vertebral Artery.—This vessel has, according to Prof. Gross, been tied on five occasions, and four times successfully; but it does not appear that the operation has ever been attempted for aneurism of the vertebral artery itself. Compression and styptics, after laying open the sac, proved successful in a case of traumatic aneurism of the vertebral, recorded by Kocher, of Bern.

Subclavian Aneurism.—The statistics of this serious affection have been particularly investigated by Sabine, of New York, Koch, and Poland. The following table shows the results of various modes of treatment in 122 cases collected by the last-named writer:—

[1] Pilz gives thirty-eight cases of ligation of the common carotid by Brasdor's method, for all aneurisms, recovery having been obtained in twelve, with twenty-five deaths, and one unaccounted for (*Half-Yearly Abstract of Med. Sciences*, vol. xlviii. p. 158).

Mode of treatment.	Cases.	Recovered, or in process of recovery.	Died.	Uncertain.
1. None, or medical treatment only	49	13	31	5
2. Moxa and hypodermic injection of ergot[1]	1	1	. .	. .
3. Direct compression[2]	3	3	. .	. .
4. Compression on cardiac side[3]	1	1	. .	. .
5. Injection of coagulating fluids[4]	2	. .	2	. .
6. Acupressure of axillary and innominate	1	. .	1	. .
7. Manipulation	4	2	2	. .
8. Galvano-puncture	1	1	. .	. .
9. Operation for ligation of innominate or subclavian begun, but not completed	7	1	6	. .
10. Ligature of subclavian (3d portion), embracing cases of subclavio-axillary aneurism[5]	21	9	12	. .
11. Ligature of subclavian (1st portion), subclavio-axillary in one case	11	. .	11	. .
12. Ligature of innominate	12	. .	12	. .
13. Ligature of innominate, carotid, and vertebral	1	1	. .	. .
14. Ligature of subclavian and carotid[6]	1	. .	1	. .
15. Ligature of subclavian, carotid, and vertebral	1	. .	1	. .
16. Ligature of axillary } (Brasdor)[7]	4	. .	4	. .
17. Ligature of carotid	1	. .	1	. .
18. Amputation at shoulder-joint[8]	1	1	. .	. .
	122	33	84	5

From the above figures it will be seen that the most promising methods of treatment are the medical and hygienic, with compression in suitable cases. Manipulation and galvano-puncture are also worthy of further trial. The Hunterian operation is justifiable in cases in which the aneurism is situated in the third portion of the vessel, so that a ligature can be applied outside of the scaleni muscles, or even between them—the case under such circumstances approximating to one of axillary aneurism. When, however, the disease involves the second portion of the artery, the surgeon can only choose between ligation of the innominate (first practised by Mott), ligation of the first part of the subclavian, and some form of the distal operation.

The *innominate* artery has, in all, been tied in twenty-one cases, of which twenty proved fatal. The only instance of recovery is that in which Dr. Smyth, of New Orleans, tied also the carotid and vertebral, the patient surviving ten years and then dying from hemorrhage from the sac, into which the blood had found its way through the subscapular artery.

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[1] Dutoit has recently reported a case successfully treated by hypodermic injections of ergotine, supplemented by digital pressure on the cardiac side of the sac; Gay has also recently recorded a case in which compression was employed with marked advantage.

[2] Direct compression has proved successful in a fourth case reported by Mr. Holmes.

[3] A case cured by *distal* compression has been recently recorded by Warren Stone, of New Orleans.

[4] Dr. Levis, of this city, tried the introduction of *horsehairs*, with a fatal result.

[5] Another (fatal) case has recently occurred in the practice of Sir W. Fergusson.

[6] A successful case has been since recorded by Dr. Little, of New York.

[7] Successful cases have since been reported by Prof. Toland, of San Francisco, and Dr. Forbes Moir, of Aberdeen.

[8] Unsuccessful cases have been since recorded by Mr. Holden, Mr. H. Smith, and Mr. Heath; no effect was produced in Smith's case, which terminated fatally from rupture of an intrathoracic portion of the aneurism; in Heath's case acupuncture was afterwards tried, but the patient died eighteen days subsequently. In a fifth case, recorded by Mr. Rose, the carotid was also tied, and the aneurism was practically cured four weeks after the operation, though hemiplegia had followed the interference with the cerebral circulation.

Cases of Ligation of the Innominate Artery.

No.	Reporter.	Result.	No.	Reporter.	Result.
1	Mott,	Died.	12	Pirogoff,	Died.
2	Graefe,	"	13	Bujalski,	"
3	Norman,	"	14	Id.	"
4	Arendt,	"	15	Bickersteth,	"
5	Hall,	"	16	O'Grady,[1]	"
6	Bland,	"	17	Smyth,[2]	Recovered.
7	Lizars,	"	18	Porter,[3]	Died.
8	Dupuytren,	"	19	Hutin,[4]	"
9	Cooper,	"	20	Lynch,[5]	"
10	Id.	"	21	Buchanan,[6]	"
11	Gore,	"			

The *first portion of the subclavian* has, including McGill's case of temporary occlusion, been tied nineteen times, and in every instance with a fatal result. Seventeen of these operations were upon the right side, and two (Rodgers's and McGill's) upon the left.

Cases of Ligation of the first portion of the Subclavian Artery.

No.	Reporter.	Result.	No.	Reporter.	Result.
1	Colles,	Died.	11	Bayer,	Died.
2	Mott,	"	12	Liston,[8]	"
3	Hayden,	"	13	Parker,[9]	"
4	O'Reilly,	"	14	Hobart,[10]	"
5	Partridge,	"	15	Cuvillier,[11]	"
6	Liston,	"	16	Kuhl,[12]	"
7	Rodgers,	"	17	Ayres,[13]	"
8	Auvert,	"	18	Becker,[13]	"
9	Id.[7]	"	19	McGill,[14]	"
10	Arendt,	"			

We thus have 40 cases of ligation of either the innominate or the first part of the subclavian, or, considering cases of subclavian aneurism only, 31 instances of the proximal operation, with only one recovery—surely not enough to justify a repetition of the proceeding unless in very exceptional circumstances. If the operation is to be done at all, Dr. Smyth's example should be followed, and the vertebral and carotid secured, as well as the innominate.

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[1] In this case the carotid also was tied. [2] Carotid and vertebral also tied.

[3] Modified acupressure employed in this case.

[4] Operation for secondary hemorrhage.

[5] Operation for hemorrhage after gunshot wound.

[6] After opening sac; patient died in a few minutes.

[7] Case of axillary aneurism. [8] Carotid also tied.

[9] Carotid and vertebral also tied.

[10] Distal operation for aortic aneurism; carotid also tied.

[11] Traumatic aneurism from bayonet wound; carotid also tied.

[12] Operation for malignant tumor of head.

[13] For secondary hemorrhage following gunshot wound.

[14] First part of left subclavian temporarily compressed with torsion forceps; pleura wounded; death on sixth day.

The *distal* operation has been somewhat more successful, but is still unpromising. What course then is to be pursued for an aneurism which involves the first or second portion of the subclavian, and which resists bloodless treatment? *Amputation at the shoulder-joint* (which would act as a modified distal operation) would under such circumstances probably be the best procedure. It would, as pointed out by Fergusson, who suggested the plan, have the advantage over the ordinary distal method of diverting the force of the circulation by removing the part which previously demanded an arterial supply. This method has been put in practice by Prof. Spence and Messrs. Holden, H. Smith, Heath, and W. Rose, and in the first- and last-named surgeons' cases with good results; it might also be properly adopted in cases of aneurism of the third portion of the artery, in which, from any circumstance, the vessel could not be reached beyond the scaleni muscles. Willett has suggested that the carotid should be tied (distal operation) in addition to amputation, and this was done in Rose's case above mentioned.

Axillary Aneurism.—This, which is a less frequent affection than subclavian aneurism, admits of several modes of treatment. Compression upon the third portion of the subclavian, either by the finger, or instrumentally (the patient being anæsthetized), should be tried, and may sometimes prove successful, as in a case recorded by Lund, of Manchester; advantage might also be obtained from the flexion method, the arm being bandaged across the chest. If it be determined to resort to severer measures, the surgeon must choose between ligation of the axillary below the clavicle, ligation of the third portion of the subclavian, the old operation, and amputation at the shoulder-joint. *Ligation of the axillary* below the clavicle has been done for aneurism (as a Hunterian operation) in 21 cases,[1] with 8 deaths, giving a mortality of 38 per cent. The statistics of *ligation of the third part of the subclavian*, for axillary aneurism, are slightly more favorable, 67 cases, according to Koch, giving but 23 deaths—a mortality of only 34 per cent. Hence, the latter operation should, I think, be preferred, particularly as on theoretical grounds it would seem to be safer—ligation below the clavicle being of the nature of Anel's, rather than of Hunter's, method. Ligation of the third portion of the subclavian is, however, in itself a very serious operation,[2] and it is, therefore, worth while to inquire, with Mr. Syme, whether the *old operation* might not in some cases be preferable. Statistics are as yet wanting to decide this question, but the operation, which was twice successfully resorted to by Syme himself, is at least worthy of further trial. *Amputation at the shoulder-joint* for axillary aneurism was successfully performed by Syme, and likewise by Morton, of this city, for hemorrhages and gangrene after ligation of the second portion of the subclavian. Either this, or the "old operation," would be necessarily indicated in any case of axillary aneurism which had become diffused, or which threatened external rupture or gangrene of the limb. Amputation would probably be the safer proceeding, but would of course have the disadvantage of necessarily sacrificing the upper extremity. Hemorrhage during either operation might be prevented by compressing the subclavian over the first rib, through a preliminary incision above the clavicle.

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[1] Koch gives 26 cases, of which, however, 5 appear to have been for subclavian aneurism (distal operation); one of these was the case in which Porter acupressed the axillary artery, and subsequently the innominate.

[2] The mortality *for all causes* is, according to Norris's statistics, 43½ per cent. (*Am Journ. of Med. Sciences*, July, 1845), and according to Koch's, no less than 51 per cent. Of 48 cases recorded during our late war, 37 terminated fatally, a mortality of over 77 per cent.

Aneurisms of the Arm and Forearm.—Aneurism of the brachial artery is a rare affection, of which Dr. L. E. Holt has been able to collect but 17 cases, including one of his own. When involving the uppermost part of the artery, immediately below the axilla, it may be treated by compression or by flexion, and, if these fail, by the "old operation" or by amputation, either of which would probably be safer than ligation of the axillary, whether in the armpit or below the clavicle. For aneurism of the brachial at a lower point, or of either of its branches, if compression fail, the Hunterian operation should be employed. The traumatic and arterio-venous aneurisms met with at the bend of the elbow, as the result of venesection, are best treated by the "old operation" (see pp. 198, 199).

Abdominal and Inguinal Aneurisms.—Dr. Murray, of Newcastle-on-Tyne, cured an aneurism of the *abdominal aorta* by instrumental compression above the sac, in five hours (the patient being under the effect of chloroform); and Dr. Heath, of Sunderland, is said to have been equally successful by using pressure, without anæsthesia, continued for twenty minutes—irregular compression for ten hours, with chloroform, having previously failed. A third successful case has been reported by Dr. Moxon and Mr. Durham, a fourth by Dr. Greenhow, and a fifth by Dr. Philipson. This mode of treatment is, however, not entirely free from danger; a patient of Bryant's died eleven hours after the removal of the clamp (which in this instance was applied over the aorta on the *distal* side of an aneurism of the *cœliac axis*), an autopsy revealing extensive peritonitis due to the pressure of the instrument; a second case, under the care of Paget and Bloxam, terminated fatally in eight days from peritonitis and visceral infarctus; a third case is mentioned by Holmes as having proved fatal in the practice of Mr. Durham; a fourth (in a case of varicose aneurism of the aorta and left common iliac vein) terminated fatally from gangrene of the intestine under the care of Mr. Simon; and a fifth, from a rupture of the sac, in a patient treated by distal compression by Dr. Skerritt, of Bristol. Still, the successful result in the first-mentioned cases undoubtedly brings within the range of surgical treatment an affection otherwise almost hopeless. The instrument to be employed may be either Skey's or Lister's (Figs. 27, 28), and the pad must be accurately held in place over the aorta, as complete interruption of the circulation is required. The distal ligature has proved futile in cases of aneurism of the aorta, or of its abdominal branches, while the Hunterian operation is manifestly out of the question.

Aneurism of the *common iliac artery* may be treated by compression on the cardiac side of the sac, the patient being in a state of anæsthesia. Cases are recorded by Mapother, Heath, Eck, and others, in which satisfactory cures have been in this way obtained. If possible, the compressing pad should be applied over the iliac artery itself, but if the size of the tumor will not permit this, over the aorta. Varick's case of successful distal compression has already been mentioned.

Ligation of the abdominal aorta for inguinal aneurism, was first performed by Sir Astley Cooper,[1] in 1817, and has been since repeated by James, Murray, Monteiro, South, McGuire, of Richmond, Va.,[1] Stokes, of Dublin (by Porter's method of modified acupressure), and Watson, of Edinburgh.[2] Czerny, of Vienna, has also tied the aorta for hemorrhage following a gunshot wound, after previous ligation of the external and common iliacs, and Czerny, of Heidelberg, for hemorrhage during an operation for extirpation of the kidney. All of these cases proved fatal, though Monteiro's patient survived until the tenth day. In Cooper's, James's, and Watson's cases, the incision was made through the linea alba, and in the others on the left side, as in ligating the common iliac. The uniformly fatal result of this operation should forbid its employment, unless under very exceptional circumstances. If, however, the patient were dying from hemorrhage, and the common iliac could not be secured, as happened in the cases of Cooper, McGuire, Watson, and Czerny, ligation of the aorta would seem to be not only justifiable, but absolutely necessary.

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[1] Sir Astley Cooper's operation, perhaps the boldest in the history of surgery, has been much criticised—many surgical writers following Guthrie in believing that it is always possible to secure the common iliac through an incision on the opposite side of the abdomen. That this is not always so, is shown by Stokes's case, in which the

Ligation of the common iliac artery (which was first practised, in 1812, by Gibson, of this city, in a case of gunshot injury) may be required in cases of aneurism involving the common iliac artery, or either of its branches. To the 32 cases collected by Dr. Stephen Smith, of New York, may be added a fatal one recorded by Baudelocque, and 34 since reported, viz., the successful cases of Bickersteth, Brainard, Luzenburg, Cock, McKinlay, Caldas, Chiappini, Richter, and Sands, and the fatal cases of Gurlt, Bünger, Hammond, Hargrave, Maunder, Watson, Delisle, Baxter, Czerny, Busch, McKee, Isham, Cutter, Hamilton, Baker, Ingram, Barral, D'Almeida, Pitta, Barbosa, Ladureau, Gouley, Carr, C. T. Hunter, and A. B. Mott. Of the whole 67 cases, but 16 terminated successfully—a gloomy record which hardly warrants a resort to this proceeding unless in exceptional cases.

It is probable that the *old operation* would, in some cases of aneurism of the common iliac, be preferable to ligation of that vessel, as it certainly would be to ligation of the aorta. This procedure has, however, not yet been employed; it was attempted by Cooper in the case in which that surgeon tied the aorta, and was believed to have been performed in a case of iliac aneurism operated on by the late Mr. Syme. In this instance, the loss of blood was prevented by the use of Lister's aortic compressor, and the patient recovered from the operation, but died about three months afterwards from pleurisy—when an autopsy showed the aneurism to have been of the external iliac, the ligatures having been really applied below the bifurcation of the common trunk.

Aneurisms of Internal Iliac and Branches.—Aneurisms of the internal iliac, and of the pudic artery, are extremely rare, there being, according to Erichsen, but one case of each known. Aneurisms of the gluteal and ischiatic arteries are more common, and may be treated in a variety of ways. Fischer,[3] of Hanover, has particularly investigated the statistics of these affections, and from an analysis of 35 cases (14 of traumatic and 21 of spontaneous aneurism) concludes that the injection of the perchloride of iron is the best mode of treatment. If this method fail, or if it be not thought proper to employ it, it would further appear that for traumatic aneurisms the

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incision was made on the *left* side for a *right* iliac aneurism, and yet "any attempt to deligate the common iliac would," it was found, "be impracticable," on account of the overlapping and adhesion of the aneurismal tumor. (*Dub. Quart. Journal of Med. Science*, Aug. 1869, p. 5.)

[1] In this case, it was intended to tie the common iliac, but the aneurism was found to involve the aorta, and burst during the examination. (*Am. Journal of Med. Sciences*, Oct. 1868, p. 415.)

[2] For secondary hemorrhage, after previous ligation of the common iliac.

[3] Archiv für klin. Chirurgie (Langenbeck), xi. Band, 3 Heft, S. 827.

"old operation," as practised by Bell, Syme, Bickersteth, Hussey, and Darby, of New York, and for those of a non-traumatic nature ligation of the internal iliac, are the measures to be preferred. The following table is compiled from Fischer's paper:—

MODE OF TREATMENT.	TRAUMATIC.				SPONTANEOUS.				AGGREGATE.			
	Cured.	Died.	Not stated.	Total.	Cured.	Died.	Not stated.	Total.	Cured.	Died.	Not stated.	Total.
None, or medical only	..	2	..	2	1	3	1	5	1	5	1	7
Compression	..	..	1	1	1	..	..	1	1	..	1	2
Galvano-puncture	..	1	..	1	..	..	..	..	..	1	..	1
Old operation	3	1	..	4	..	..	..	..	3	1	..	4
Ligature of gluteal[1]	1	1	..	2	..	..	..	..	1	1	..	2
" " internal iliac	..	2	..	2	5	3	..	8	5	5	..	10
" " common iliac	..	1	..	1	..	2	..	2	..	3	..	3
Injection of perchloride of iron	1	..	..	1	3	2	..	5	4	2	..	6
Summary	5	8	1	14	10	10	1	21	15	18	2	35

Mr. Holmes, who rejects one of Fischer's cases as an example of aneurism by anastomosis, recommends, after a careful examination of recorded cases, compression, either rapid or gradual, applied to the aorta or common iliac, and aided if need be by galvano-puncture or the use of coagulating injections; if these means fail, the internal iliac should be tied, unless the surgeon think that he can find the artery outside of the pelvis, in which case the old operation, or ligation on the proximal side of the sac by Anel's method, would be preferable. Dr. Sands reports a case of gluteal aneurism treated (without benefit) by digital compression through the rectum.

Cases of Ligation of the Internal Iliac Artery.

No.	Operator.	Result.	No.	Operator.	Result.
1	Altmüller,	Died.	16	Mott,	Recovered.
2	Anger,[2]	Died.	17	A. B. Mott,[3]	Died.
3	Arendt,	Recovered.	18	Oeverent,	"
4	Atkinson,	Died.	19	Porta,[4]	"
5	Bigelow,	"	20	Stevens,	Recovered.
6	Cianflone,	"	21	Syme,	"
7	Coluzzi,	"	22	Thomas,	Died.
8	Galozzi,	Recovered.	23	Thompson,[3]	"
9	Higginson,	Died.	24	Torracchi,	"
10	Kasinsky,	Recovered.	25	Tripler,[3]	"
11	Kimball,	Died.	26	White,	Recovered.
12	Landi,	"	27	Case in Bellevue Hospital, referred to by Van Buren,	Died.
13	McKee,[3]	"			
14	McLean,	"			
15	Morton,[4]	Recovered.			

The *old operation* is particularly adapted to cases of *traumatic* aneurism, as in these the communication with the artery will be certainly within reach; to prevent hemorrhage during the operation, Bickersteth's plan should be adopted, and the circulation controlled by means of the aortic tourniquet. In a case, however, of *spontaneous* gluteal or ischiatic aneurism, the surgeon could seldom be sure that the sac did not extend within the pelvis, and hence in such a case, *ligation of the internal iliac* would commonly be a safer procedure. This artery has been tied on at least twenty-seven occasions, eight times successfully, and nineteen times with a fatal result.

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[1] Another case of ligation of the gluteal artery for traumatic aneurism has since been recorded by T. A. McGraw.

[2] For rupture of ischiatic artery.

[3] For hemorrhage.

[4] Case of malignant disease.

Iliac and Femoral Aneurisms.—Aneurisms involving the *external iliac* or *common femoral* arteries, should be treated, if possible, by compression on the cardiac side of the tumor, but if this fail, ligation of the external iliac, or possibly of the common trunk, will be required. The *rapid pressure* treatment has, according to Holmes, succeeded in seven out of ten cases in which it has been resorted to. Other successful cases have since been recorded by Staples, and by Agnew, of this city. R. Perssé White, of Dublin, has successfully employed Porter's method of *modified acupressure*, while *acupuncture* (in conjunction with proximal compression) has been successfully resorted to by Dr. William Macewen, of Glasgow. Dr. Levis, of this city, introduced horsehair into an iliac aneurism, the sac sloughing and the patient, after ligation of the external iliac artery, dying from peritonitis. Dr. George W. Norris collected, in 1847, 118 cases of *ligation of the external iliac* (first performed by Abernethy, in 1796), to which may be added 35 collected by Dr. Cutter, of Newark, and 16 tabulated in Circular No. 6. This gives 169 operations for all causes, the mortality being 61, or a little over 36 per cent. If cases of aneurism alone are considered, the results are still more favorable, 126 cases then giving 35 deaths, a mortality of less than 28 per cent. The "*old operation*" has been successfully employed in a case of iliac aneurism by Buchanan, of Glasgow.

Aneurism of the Deep Femoral Artery (*Profunda*) is very rare, Holmes referring to but five cases, two observed by Erichsen, two by Cock, and one by P. H. Watson. The treatment would consist in compression at the groin, or, if this should fail, in ligation of the common femoral, or, which many consider safer, of the external iliac. *Ligation of the common femoral artery* is recommended by Holmes for these cases, and for those of aneurism of the superficial femoral, which are situated at too high a point to admit of ligation below the place of bifurcation; and ten cases of the former operation are referred to, of which only three proved fatal. Other writers, however, give a different estimate of the results of this procedure. The operation is probably attended with more risk than ligation of the external iliac, but has, on the other hand, the advantage of being much more easily performed. Rabe has collected nearly 400 cases of ligation of the external iliac and common femoral arteries, and finds that the risk of gangrene after the former operation is but 11 per cent. as compared with 18 per cent. after the latter, and the risk of hemorrhage but 15 per cent. as compared with 39 per cent.[1] In the *American Journal of Medical Sciences* for July, 1868, p. 134, is recorded a case in which I secured the common femoral artery by *acupressure*. Lister and Pemberton have successfully tied the same vessel with carbolized catgut.

Aneurisms of the Superficial Femoral and Popliteal Arteries are the most frequent of all external aneurisms, the former vessel giving 66, and the latter 137, out of 551 cases of aneurism of all parts, collected by Crisp. The treatment consists in compression, or in ligation by the Hunterian method. The considerations which should guide the surgeon in choosing between these modes of treatment have already been set forth, and need not be again referred to (pages 557, 562). Popliteal aneurisms are particularly adapted to the treatment by flexion, and by the use of Esmarch's bandage. The latter mode of treatment is, according to Bellamy, most apt to succeed when the sac already contains a certain amount of fibrinous clot.

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[1] Deutsche Zeitschrift f. Chirurgie, apud Hayem, Revue des Sciences Médicales, Oct. 1875.

Ligation of the superficial femoral artery would appear to be a more successful operation when performed for femoral, than when for popliteal, aneurism, the reason being that the risk of gangrene from venous congestion is much greater in the latter case than in the former. This is seen very clearly from Norris's statistics, which embrace 22 cases of ligation for femoral aneurism, with only one death (from hemorrhage), and 154 cases of the same operation for popliteal aneurism, with 39 deaths—of which no less than 19 were from gangrene. Norris's table embraces in all 204 cases, with 50 deaths and 154 recoveries; or, if femoral and popliteal aneurisms alone are considered, 176 cases, with 40 deaths and 136 recoveries—consecutive amputation having been performed in 5 of the successful and in 6 of the unsuccessful cases. The mortality of ligature of the femoral artery for femoral and popliteal aneurism is, according to these statistics, 22.7 per cent., or about one in four and a half. Crisp's statistics are more favorable, giving 122 cases, with 107 recoveries (7 after amputation) and only 15 deaths, a mortality of but a little over 12 per cent., and this is, according to Holmes, about the death-rate of the operation in London hospital practice of the present day. Syme's remarkable record of 35 operations, with only one death, has already been mentioned.

Diffused aneurism of the *popliteal* artery usually requires amputation; while if the *femoral* be the vessel affected, the "old operation" may be advantageously substituted, as has been done, with the most gratifying results, by Birkett and by Forster.

Aneurisms of the Arteries of the Leg and Foot are extremely rare, but if met with, should be treated by compression, etc., or, if necessary, by ligation on the cardiac side of the tumor. The injection of perchloride of iron proved successful in a case of tibial aneurism reported by Denucé.

The *lines for the ligation of the various arteries* have already been given (pages 199–207).

CHAPTER XXX.

DISEASES OF BONE.

The diseases of bone may be divided into those which depend upon the inflammatory process, and those which involve structural, non-inflammatory changes. The affections which are to be considered under the first head are Periostitis, Osteitis, Osteo-myelitis, Epiphysitis, Abscess, Caries, and Necrosis.

Inflammatory Diseases of Bone.

Periostitis, or *Inflammation of the Periosteum,* is a frequent consequence of wounds or other injuries, or of certain diseases, as Syphilis. It may be *primary,* or may be *secondary,* to inflammation of the bone itself, or of its medulla. The *Pathological Changes* in periostitis consist in swelling (*temporary hypertrophy*) of the periosteum, followed by rapid cell-proliferation of its deep or osteogenetic layer, or a rapid accumulation of wandering cells (see pages 37 and 225), and resulting in the production of inflammatory lymph; these changes may be quickly arrested, the part returning to its former condition, and the newly formed material being gradually utilized in the normal maintenance of the bone—or the part may remain permanently thickened, or in a state of *sclerosis* or *induration*. These changes are usually accompanied by a softening or medullization of the superficial layer of the bone. If the irritation be more intense (as is seen in *diffuse periostitis*), there may be a rapid formation of pus, when necrosis of the subjacent bone is apt to follow. T. Smith has described, under the name of *hemorrhagic periostitis*, a condition in which bleeding occurs between the periosteum and the bone.

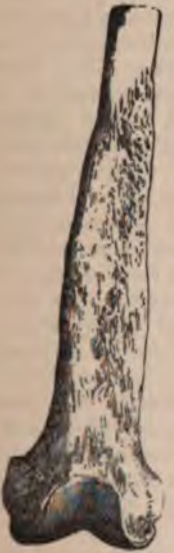
Symptoms.—The symptoms of ordinary periostitis are those of deep-seated inflammation in general, viz., swelling, corresponding to the extent of inflamed periosteum, heat, pain, tenderness on pressure, etc. The pain is apt to be worse at night. The attachment of the periosteum to the subjacent bone is loosened, giving sometimes a puffy or even boggy feel to the part. In *diffuse periostitis* (which is much the most serious form of the affection, and which chiefly involves the long bones, especially the femur, tibia, or humerus, and is usually the result of injury, in young persons of a strumous diathesis), the inflammation rapidly spreads, frequently involving the periosteal covering of the entire shaft, and if (as is sometimes the case) complicated with osteo-myelitis, perhaps attacking the epiphyses and neighboring joints as well. In this form of the disease the production of lymph, and subsequently of pus, is rapidly effected, giving rise to the condition known as *Subperiosteal Abscess*. There is usually a good deal of constitutional disturbance, and fatal pyæmia not unfrequently occurs in the course of the affection.

Diagnosis.—The ordinary circumscribed form of periostitis is easily recognized: the diffused variety may be mistaken for *diffuse inflammation of the areolar tissue*, or for *rheumatism*. From the former it may be distinguished by its not spreading beyond the neighboring joints, and from the latter by the history of the case, and by the early occurrence of suppuration.

Treatment.—The treatment of circumscribed periostitis consists in the application of poultices, preceded perhaps by a few leeches, with opium to relieve pain, and, in the more chronic stages, in the use of blisters and the administration of the iodide of potassium. Advantage may often be derived from a free or subcutaneous incision, so as to relieve the tense state of the periosteum, and encourage resolution. In the treatment of the *diffuse* form of the disease, no time should be lost in making free incisions through the inflamed periosteum, so as to relax the parts, and allow the escape of pus, if there be any; these incisions should be so arranged as to allow of free drainage, and should be repeated as often as necessary. At the same time, the strength of the patient must be maintained by the use of concentrated food and stimulus, and by the administration of tonics (especially quinia), with anodynes to relieve pain. In favorable cases, the patient may recover with the loss of more or less bone by necrosis, but pyæmia will often lead to a fatal termination. If the destruction of bone be evidently too great for the recuperative powers of nature to cope with, and particularly if the neighboring joints become implicated (*pyarthrosis*), showing that the affection is probably complicated with suppurative osteo-myelitis, amputation should be performed—if the patient is in a condition to bear it—and I have under such circumstances removed the arm at the shoulder-joint, with the happiest result. The statistics of amputation for subperiosteal abscess, particularly in the femur, are, however, so gloomy, that the operation can only be looked upon as a last resort.

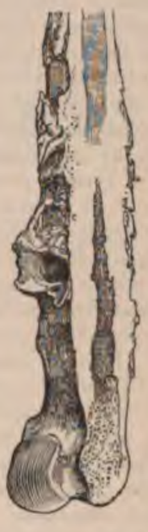
Osteitis, or *Inflammation of the Osseous Tissue* itself, is seldom if ever met with as a *primary* affection, though it is a very frequent *secondary* complication of either periostitis or osteo-myelitis. In fact, in the large majority of cases, whichever constituent of bone is first affected, all are sooner or later involved. The first *Pathological Change* due to ostéitis is a *softening* or *medullization* of the bone tissue. Absorption of the earthy constituents occurs, while the Haversian canals, lacunæ, and canaliculi become widened, many disappearing by the coalescence of numerous spaces and canals. "The enlarged Haversian canals," says Paget, "present the appearance of medullary spaces, and are filled with a soft, rapidly growing tissue not unlike that of granulations." This process is rapidly accomplished, Ollier having seen complete medullization of the phalanges, without necrosis, in the short space of twenty days. As the result of this medullization, the bone becomes enlarged (though it loses in weight), the layers of its walls becoming separated, and thus giving a porous appearance—whence this condition is called *rarefaction* or *osteo-porosis*. The bone often at the same time becomes elongated, from transference of irritation to the epiphyseal cartilage. Paget has described, under the name of *osteitis deformans*, a condition in which the bones yield to pressure and become much distorted. Three out of four cases terminated in the development of cancer.

FIG. 269.



Osteo-porosis of femur. (DRUITT.)

FIG. 270.



Sclerosis and eburnation of femur. (LISTON.)

If the irritation be intense or continued, the process of medullization, or *decalcification*, as it is also called, may run on to the occurrence of suppuration, with perhaps caries and necrosis; in other cases, the deposit of bony matter is renewed, the part, perhaps, eventually becoming abnormally solid and heavy, the walls being thickened and the marrow-cavity encroached upon—when the condition known as *sclerosis* or *eburnation* results. These various conditions are frequently seen in different parts of the same bone, one specimen thus often exhibiting at once osteo-porosis, eburnation, and necrosis.

Symptoms.—The symptoms of osteitis are those of periostitis, with which the disease is almost invariably complicated. The osteocopic pains are perhaps more marked, and the tenderness greater, while the limb feels heavier and more helpless.

Treatment.—The treatment is essentially that recommended for periostitis; if a deep incision do not afford relief, a longitudinal section should be made through the bone, down to the medullary canal, with a Hey's saw, or (which is better if the disease have run on to suppuration) a small disc of bone may be removed by means of a trephine. The escape of pus, if there be any, is thus permitted, and the part placed in the most favorable position for recovery.

Osteo-myelitis, as the term is used in these pages, signifies *Inflammation of the Medulla or Marrow of Bone.* This disease has been made a subject of special study by Dr. John A. Lidell, of New York, who has published by far the best account of the affection to be found in our own, if not in any, language. Osteo-myelitis may occur as a *primary* affection, or may be *secondary* to inflammation of the periosteum, or of the bone itself—being, indeed, almost invariably accompanied by osteitis or periostitis, or both. It may occasionally occur idiopathically, but is usually a traumatic affection, resulting particularly from contusions or contused wounds of bone, and hence is of special interest in military practice (see page 171). Several varieties of osteo-myelitis have been described by surgical writers, as the *acute* and *chronic*, or the *diffused* and *circumscribed.* A better classification would appear to be one founded upon the pathological condition in different cases, according as the inflammatory change is limited to cell-proliferation and the production of lymph, or runs on to suppuration, or to sloughing. We may thus speak of—1, *simple;* 2, *suppurative;* and 3, *gangrenous osteo-myelitis.*

1. *Simple Osteo-myelitis* is constantly met with in connection with osteitis and periostitis. It is present in a circumscribed form in many cases of simple fracture, in which, by causing a retrograde metamorphosis into bone, it gives rise to the so-called pin callus. The pathological change which characterizes simple osteo-myelitis is called by Lidell *carnification* or *hepatization of the marrow.* "The first anatomical alteration in osteo-myelitis, beyond mere hyperæmia of the involved bloodvessels, appears to be," according to Dr. Woodward, "cell multiplication affecting the connective tissue corpuscles of the marrow, and of the connective tissue surrounding the bloodvessels in the canals of Havers. As a consequence, the true osseous tissue is encroached upon, and the portions of it which immediately adjoin the multiplying connective tissue disappear. . . . It appears probable . . . that the bone cells which occupy the lacunæ next to the multiplying connective tissue themselves enlarge and multiply, the matrix between them being absorbed, and that thus the bone cells themselves contribute to the resulting granulation tissue. The fat in the adipose tissue cells of the marrow is also absorbed, and these cells appear to contribute by their multiplication to the granulation tissue formed, as is the case in inflammation of the subcutaneous adipose tissue." This granulation tissue of simple osteo-myelitis can be well seen in the florid button of granulations which covers the sawn end of a bone, in the stump of an amputation. Carnified marrow is of a tough, almost fibrous, consistence, and usually of a more or less vivid red color, sometimes yellowish from the admixture of fat or of imperfectly organized lymph, or deep red, or almost black from hemorrhagic extravasation, which Lidell calls apoplexy of the marrow.

Carnified marrow may gradually return to its normal state, or may run on to suppuration, or, on the other hand, may undergo a retrograde metamorphosis, giving rise to the formation of a cylinder of bone, and perhaps to complete obliteration of the marrow-cavity. This is a not infrequent termination of simple osteo-myelitis.

2. *Suppurative Osteo-myelitis*[1] may be regarded as a later stage of the preceding. In the large majority of cases, suppurative is preceded by simple osteo-myelitis, the lymph corpuscles of the granulation tissue of the latter being converted into pus corpuscles, and suppuration beginning in several distinct foci, which afterwards coalesce. In some instances, however, under the depressing effect of bad hygienic or constitutional influences, the production of pus is so rapid as to render the suppurative form of the disease to all intents and purposes a primary affection. If the pyogenic change be limited to a small area, the condition known as *Circumscribed Suppuration* or *Abscess of Bone* is produced—an affection which is quite amenable to treatment (see page 583). If, on the other hand, the medullary suppuration be diffused,[2] involving, perhaps, the whole marrow-cavity, the affection becomes one of the gravest character—wide-spread necrosis resulting as an almost necessary consequence, even if the occurrence of pyæmia do not lead to a fatal result.

3. *Gangrenous Osteo-myelitis* is a comparatively rare affection. It occurs, just as inflammatory gangrene in other parts, from a higher grade of irritation than is concerned in the production of the simple or suppurative varieties. When attacked by gangrenous osteo-myelitis, the marrow assumes a very dark, almost black, hue, and has a gangrenous odor. When examined with the microscope, the cell-formations are, according to Lidell, found to have been destroyed, amorphous matter (the *débris* of pre-existing histological structures) alone remaining, with perhaps some connective tissue—all stained of a dark color by decomposing hæmatoidin. The same bone may be, at the same time, affected in a different part by each of these varieties of osteo-myelitis.

Osteo-myelitis, in whatever form it appears, has a marked tendency to spread *towards the trunk*—the upper portions of the long bones (at least in the case of the femur and humerus, which are the bones most often affected) being almost always more seriously involved than the lower. In a case, however, of osteo-myelitis affecting the *tibia*, observed by Dr. H. Allen, the lower portion of the medulla was most inflamed.

Beside the immediate risks of osteo-myelitis, of which the chief is unquestionably the occurrence of *pyæmia*, serious consequences may ensue from the implication of the other constituents of the affected bone; thus, as the result of secondary osteitis, there may be *caries*, or *necrosis*, which may involve the internal laminæ only (*central necrosis*), or, if accompanied with diffuse periostitis and subperiosteal abscess, may involve the external laminæ only (*peripheral necrosis*), or may cause the destruction of the whole thickness of the shaft (*total necrosis*). Again, from extension in a longitudinal direction, *separation of the epiphyses* may follow, or, the epiphyses themselves being involved, ulceration of the articulating cartilages and secondary *pyarthrosis* of the neighboring joints may ensue.

Symptoms and Diagnosis of Osteo-myelitis.—Simple osteo-myelitis is ordinarily attended by no recognizable symptoms, being indeed usually a conservative process which can scarcely be called morbid. When it does pass the border-line between health and disease, its symptoms are indistinguishable from those of the osteitis and periostitis by which it is accompanied. Even suppurative and gangrenous osteo-myelitis can rarely be recognized during life, unless the bone affected be in an unhealed stump, when the protrusion from the marrow-cavity of a suppurating or sloughing fungous mass, or an exploration with the finger or probe, would, of course, indicate the nature of the affection. Under other circumstances, the symptoms will be usually completely masked by those of the accompanying diffuse periostitis; if, however, as remarked by Dr. Lidell, the free incisions which were recommended for the latter affection should fail in any case to give relief, the surgeon would properly infer that the medullary cavity was involved. A similar inference would be justifiable from the occurrence of pyarthrosis, or epiphyseal separation, or even from the pain and constitutional disturbance being more intense than could be accounted for by the existence of osteitis and periostitis alone.

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[1] Suppurative osteo-myelitis is often supposed to be due to the contact of infectious materials, and its occurrence to be preventable by the adoption of Lister's mode of dressing; but Colin has shown by experiments on the lower animals that it is not excited by prolonged exposure of any part of the bone to the atmosphere, nor even by the application of putrid substances; its development seems to be rather due to the action of constitutional causes.

[2] This is the only form of the disease which is recognized under the name of osteo-myelitis by many systematic writers.

Treatment.—The treatment of *simple osteo-myelitis* is essentially that recommended for osteitis, the longitudinal section with Hey's saw being equally applicable in these cases. If the existence of *suppurative osteo-myelitis* be ascertained, an attempt may be made to preserve the limb by making one or more openings with the crown of a small trephine, so as to expose the marrow-cavity and allow the exit of pus. This plan was employed in the year 1798, by the late Dr. Nathan Smith, with the happiest results, and has been more recently adopted by his son, Morven Smith, and by several other surgeons, including Frank, Boeckel, Péan, and myself. If the affection involve the whole extent of the medulla—particularly if pyarthrosis have occurred, amputation or excision, according to the nature of the bone, may be required. If a short bone, such as the astragalus, be involved (which is seldom the case), excision may suffice; but in the case of the long bones, the choice will lie between amputation and disarticulation. Amputation in the continuity of the affected bone should be rejected, as the disease would almost certainly recur in the part that would be left; hence, disarticulation, in the case of humerus or femur, and the same, or amputation of the thigh or arm, in the case of bones of the leg or forearm, are the operations to be recommended. Disarticulation, under these circumstances, proved very successful in the hands of J. Roux and Arlaud, 20 cases, of which 2 were at the hip-joint, having all terminated in recovery.[1] The operation should be performed, if possible, before the development of pyæmic symptoms, but has been resorted to with success even at a later period by Prof. Fayrer, of Calcutta. *Gangrenous osteo-myelitis*, if recognized during life, would require amputation even more imperatively than the suppurative form of the disease.

It is, perhaps, scarcely necessary to say that amputation should not in any case be employed, unless not only the surgeon be well convinced that diffuse suppurative or gangrenous osteo-myelitis is actually present, but unless also the affection is running so acute a course as to endanger life—and unless conservative treatment, especially the use of the trephine, has failed to give relief. A large number of cases of osteo-myelitis run a comparatively chronic course, producing more or less extensive necrosis, but at no time placing life in imminent danger: as a rule, no amputation would be justifiable under such circumstances, but the dead bone should be dealt with as in cases of necrosis from any other cause.

Epiphysitis.—Under this name, Macnamara describes a state of inflammation often running on to suppuration, occurring in children at the junction of the epiphysis and diaphysis of a long bone. The affection is apt to be mistaken for arthritis of the neighboring joint, but can be distinguished by careful examination. The general symptoms correspond pretty closely with those of diffuse periostitis, which indeed often follows the original affection. The *treatment* consists in making an early and free incision, with attention to drainage, etc., and in supporting the patient by the use of quinia and alcohol. If the symptoms persist, the medullary cavity should be opened as in suppurative osteo-myelitis; amputation may sometimes be required.

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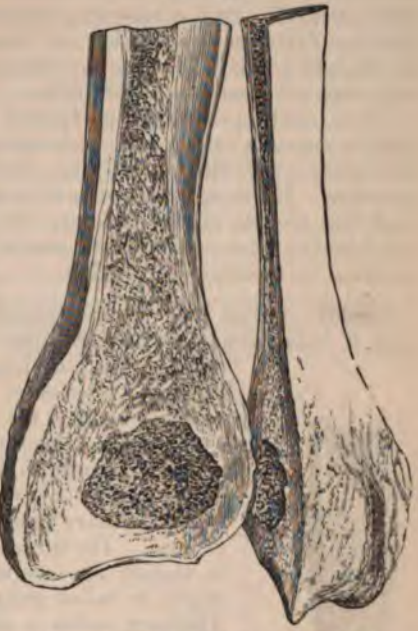
[1] Roux reports in all 22 cases, of which 4 were at the hip-joint (all successful); 2 of the hip-joint cases were, however, for affections other than osteo-myelitis.

FIG. 271.



Abscess in tibia; Brodie's case. (HOLMES.)

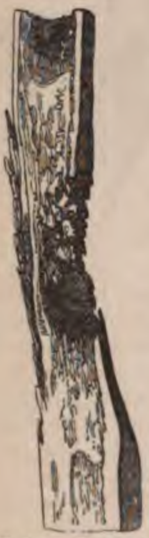
Circumscribed Suppuration or Abscess of Bone.—This painful affection may occur in any part of a bone, but is most common in the articular extremities, as in the head of the tibia. The course of the disease is usually very chronic, and is marked by symptoms of localized osteitis, especially tenderness and pain, which is most severe at night, and is aggravated by walking or other exertion. There is often some swelling and redness of skin, with concomitant periostitis. Abscess of bone has been met with under several conditions, which have been described as distinct affections, though the pathology of all is the same. Thus (1) there may be caries of the superficial portion of the bone, a narrow channel leading down to the focus of suppuration (as in the celebrated case recorded by Hey, of Leeds); or (2) there may be what Dr. Markoe, of New York, has well described as "chronic sinuous abscess of bone," in which an abscess originating in the interior of a bone makes its way towards the surface, and obtains an imperfect vent by perforating the external compact surface; or (3) there may be an abscess entirely surrounded by bone-structure, as in cases recorded by Sir Benjamin Brodie. The only affections with which abscess of bone is likely to be confounded are osteitis, circumscribed osteo-myelitis, stopping short of the production of pus, central necrosis, and cystic growths originating within the bone. A mistake under these circumstances would, however, be of no practical importance, as the same treatment would answer in either contingency.

Treatment.—The treatment consists in perforating the compact substance with a trephine at the most tender point, so as to give free vent to the contained pus, as was done by Dr. Nathan Smith, in 1798, in a case of diffused medullary suppuration (see page 582). A small trephine should be used, the bone being first exposed by means of a suitable incision; and if the abscess be not reached by the opening thus made, perforations in various directions may be made through the aperture with a drill or other suitable instrument. The cavity of the abscess is sometimes found lined with granulations, forming what is called a pyogenic membrane—or the surrounding bone may be rough and carious. In the latter case, the gouge should be freely used; while if a sequestrum be found, the opening may be enlarged in order to effect its removal, as will be described in speaking of necrosis. The use of the trephine for abscess in bone is usually said to have originated with Brodie, and to that distinguished surgeon is undoubtedly due the credit of having popularized the operation in modern times. It is, however, really an old mode of treatment, having been distinctly described by David, in an essay which received the prize of the Royal Academy of Surgery, in 1764, and by Bromfeild, in 1773. Still earlier the operation had been performed by Petit (who died in 1750), and by Walker, of Virginia (in 1757); and at a later period by Hey, of Leeds (1787), and by Simons, of South Carolina (1825)—Brodie's first case not occurring until 1828.

The operation should be performed as soon as the deep-seated pain and other symptoms render the existence of an abscess probable; and if no pus be found, relief will probably be afforded by the diminution of tension and pressure. If the operation should be delayed, there would be reason to fear that the abscess might perforate the articular cartilage, and involve the neighboring joint—an accident which might make it necessary to resort to excision, or possibly amputation.

Caries.—Caries is the name applied to *Ulceration of the Osseous Tissue*,[1] and it bears precisely the same relation to inflammation of bone that ordinary ulceration does to inflammation of the soft parts. Several varieties of caries are described by systematic writers—such as the circumscribed, diffuse, or phagedænic—the simple, scrofulous, syphilitic, etc. In caries, as in common ulceration, the dead tissue is thrown off in a state of solution, or in very minute particles; whereas in necrosis (as in ordinary gangrene) considerable masses are ejected at once. The term *caries necrotica* is used by some writers to signify an intermediate condition, analogous to what might be called gangrenous ulceration of the soft tissues. The term caries is strictly applicable only to the degenerative process in which the effete material is cast off or ejected—that in which the products of degeneration are absorbed being more properly designated as *interstitial absorption*.[2] Carious bone is porous and fragile, usually of a dark gray or brown hue, and presents numerous hollows and cavities, which are filled with the products of disintegration, often intermingled with necrosed fragments. The surrounding bone is usually indurated, though, especially in the scrofulous variety, it is often in a state of medullization—fungous granulations overlapping and masking the carious portion. Carious bone is sometimes, though not usually, sensitive; bleeds when touched with a probe; and may be felt to be softer than in the normal condition. The disintegrated material derived from carious bone consists of oil globules, blood, and various *débris*, with granular inorganic substances corresponding in chemical composition to the salts of bone. Superficial caries is accompanied with localized periostitis, the periosteum being loosened and thickened, and presenting a pink, villous appearance; these villous-looking granulations occupy the depressions of the subjacent bone.

FIG. 272.



Caries. (DRUITT.)

The *symptoms* of caries are those of osteitis complicated by an abscess leading to the softened bone; there cannot be true caries without suppuration. When the bone can be felt (as it usually can by using Sayre's jointed probe, Steel's flexible wire instrument, or the still simpler apparatus of Sarazin, which consists merely in a flexible bougie tipped with the end of a female catheter), the diagnosis is easy—but under other circumstances can only be made by observing the persistence of the suppuration and other symptoms without obvious cause, and by chemical examination of the pus, which, when proceeding from diseased bone, contains an excess of phosphate of lime. Caries may be secondary to disease of the soft parts (as in certain inveterate ulcers, particularly of the lower extremities), or may be a primary affection. In the latter case it particularly involves the cancellated tissue, and is thus most common in the short or spongy bones, and in the articulating extremities of the long bones—in which situation it not unfrequently leads to destructive disorganization of the neighboring joints. Recovery from caries, as from ulceration of the soft parts, is effected by granulation and cicatrization—a dense fibrous structure, or an imperfect form of bone, taking the place of the tissue which has been destroyed.

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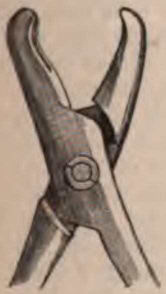
[1] Some writers limit the term caries to *scrofulous ulceration* of bone; while others (as Erichsen) consider it a distinct disease, analogous to, but not identical with, ulceration.

[2] Remarkable cases of this kind have been recorded by Barbieri, Billroth, and other surgeons.

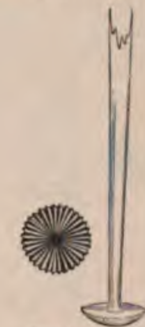
Treatment.—The treatment of caries must be both constitutional and local. If the patient be syphilitic, iodide of potassium may be administered, or if of a scrofulous diathesis, cod-liver oil with the iodide of iron. The hygienic condition should receive careful attention, and in many cases a change of air, especially residence at the seashore, will prove of great benefit. The *local treatment* during the early stages of the disease, while the ulcerative process is advancing, should usually consist merely in keeping the parts clean and free from external sources of irritation. When the acute symptoms have subsided, an attempt may be made to remove the diseased bone by means of applications of iodine or of the mineral acids. Chassaignac has highly recommended the use of dilute muriatic acid, which is injected through the fistulæ which lead to the carious bone. Mr. Pollock employs dilute sulphuric acid, applied with a camel's-hair brush, after turning back the soft parts. The use of caustics, or even of the actual cautery, has likewise been advised by various surgeons, and may occasionally prove useful. The "*Liqueur de Villate*," which was introduced by Notta, may be used as an injection, and has been favorably spoken of by many surgeons. It may be made according to the following formula: ℞. Zinci sulphatis, cupri sulphatis, āā gr. xv; liq. plumbi subacetatis f℥ss; acid. acet. dilut. f℥iijss. M. Great advantage may often be derived from the use of an *oakum seton* drawn through the carious bone, as recommended by Sayre, of New York. When the carious bone can be reached from the surface, it may be scraped or cut away with a *gouge* or *gouge-forceps*, or with a *burr-head drill* or *osteotrite*. The process should be continued until all the diseased bone has been removed, which may usually be known by the hardness and density of the surrounding healthy parts; if

FIG. 273.



Gouge-forceps.

FIG. 274.



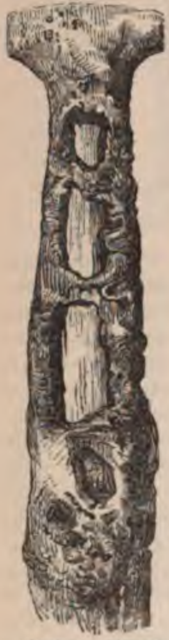
Burr-head drill.

the latter be softened by inflammation, the surgeon may know that he has gone far enough when the detritus retains its red color in spite of washing—carious bone when washed becoming white, gray, or black. When the disease is very extensive, as where it involves the whole or greater part of one of the tarsal bones, or the articulating extremity of a long bone, very free gouging (which Sédillot has recommended under the name of *évidement*) may be employed, though in many cases *excision* will be preferable. Finally, *amputation* may be necessary to prevent fatal exhaustion. Before, however, resorting to so grave an operation—and this remark applies in a less degree to any cutting operation for caries—the surgeon must consider that the affection with which he has to deal is essentially of a chronic nature, and may persist for many years, ending perhaps, eventually, in spontaneous recovery; hence, in many cases, particularly with patients who, from their social condition, can afford to be invalids, it will be more prudent, as long as life is not endangered, to avoid modes of treatment which are in themselves necessarily attended with considerable risk.

Necrosis.—Necrosis is the name given to mortification of bone; like gangrene of the soft parts, it may be acute or chronic, dry or moist, inflammatory, senile, etc.

Causes.—The most frequent *immediate cause* of necrosis is osteitis, occurring as a complication of periostitis, of osteo-myelitis, or of both. Necrosis may, however, result (just as gangrene of the soft tissues) from external violence depriving the part of vitality, without the intervention of inflammation. Under these circumstances, or in any case in which the bone is *suddenly* killed, if the cancellated structure be involved (the blood and other fluids remaining in the part), the necrosis is of the *moist* variety: this form of necrosis corresponds to the *mephitic gangrene of bone* of Dr. Lidell. In the large majority of cases, however, necrosis is slowly developed by the affected bone being deprived of its normal supply of blood; the compact structure is then chiefly involved, and the phenomena of *dry* or *ordinary necrosis* are presented. Thus in osteitis, the capillaries of the Haversian canals become strangulated, as it were, against the surrounding bony walls, and death of the part results as a consequence of arrested circulation. Among the more *remote causes* of necrosis may be particularly mentioned scrofula and syphilis, exposure to heat or cold, the application of caustics, exposure to the fumes of phosphorus, etc. The bones most often affected are the tibia, femur, humerus, phalanges, skull, lower jaw, clavicle, and ulna; unlike caries, necrosis attacks the shafts, in preference to the articulating extremities, of the long bones. Necrosis is not very common in young children (though it may occur among the sequelæ of the eruptive fevers), being most frequent in early adult life; it is sometimes seen, like ordinary senile gangrene, as a consequence simply of the diminished vitality of old age. Bone deprived of its *periosteum* usually, though not necessarily, becomes necrosed; if both *periosteum* and *medulla* perish, necrosis is almost certain to follow.

Fig. 275.



Central necrosis; new bone with cloacæ. (Erichsen.)

Dry Necrosis.—Bone affected with dry or ordinary necrosis is hard, and of an opaque, yellowish-white hue, though it may become blackened from exposure; it is insensible, sonorous when struck with a probe, and does not bleed. It may be, according to the part affected, *peripheral*, *central*, or *total* (see p. 581). The dead bone is at first connected with the surrounding parts, but becomes gradually loosened, and is finally separated and thrown off as an *exfoliation*. While the process of loosening is going on, the periosteum, if not destroyed, furnishes new bone, which often forms a sheath around the dead portion, which is then said to be *invaginated*, and when separated constitutes a *sequestrum*. The separation is effected, not, as was formerly supposed, at the expense of the dead part, by absorption, but at the expense of the surrounding living bone, which undergoes medullization, and is converted into a layer of granulations. The free surface of an exfoliation, or of a sequestrum, is pretty smooth, but the edges and deeper surfaces present a ragged or worm-eaten appearance, with depressions corresponding to the granulations by which they have been surrounded. The sheath of bone which envelops a sequestrum is called the *involucrum;* this usually presents numerous round or oval openings, which are called *cloacæ*, and through which the extrusion of the sequestrum is eventually accomplished. It occasionally happens, in cases of total necrosis, that, while the original bone is perishing, and the periosteum furnishing a new osseous sheath, the medulla, likewise by a process of retrograde metamorphosis, becomes partially ossified,[1] and the sequestrum is thus surrounded on both sides by living bone.

Moist Necrosis.—This, which is a comparatively rare form of necrosis, is well described by Lidell under the name of *Mephitic Gangrene of Bone*. This form of the disease manifests its peculiarities chiefly in the cancellated structure of bone, which, when thus attacked, is moist, more or less softened, and of a dirty gray or greenish-brown hue, with an extremely offensive odor. This form of necrosis may occasionally be seen in compound fractures, in what Dupuytren called primary splinters (see pp. 166, 234), if these be not promptly removed; it may also result from violent contusion of bone, being thus more frequent, probably, in military than in civil practice. Moist necrosis is always *total*—involving, that is, the whole thickness of the affected bone; there is little or no effort at repair on the part of nature in these cases, the periosteum either itself sloughing, or at best furnishing but a few imperfect nodules of bone.

Symptoms of Necrosis.—The symptoms of necrosis may be described as belonging to two periods, that in which the bone is dying, and that in which its separation as an exfoliation or sequestrum is effected: in moist necrosis, as the bone is at once deprived of vitality, the first stage is absent. The symptoms of the first stage of necrosis are those of osteitis, it being impossible to decide, before the occurrence of suppuration, whether necrosis is or is not about to occur. The death of any portion of the osseous skeleton is usually, though not invariably, attended by extensive suppuration of the soft parts,[2] the abscesses thus formed gradually contracting to sinuses, through which, if a probe be passed, the necrosed bone can be readily recognized by the hard and rough sensation which it communicates. In cases of central necrosis, the diagnosis can only be certainly made if cloacæ exist, through which the dead bone can be felt: if there be no cloacæ, the affection may be indistinguishable from chronic osteitis, or (as already mentioned) from circumscribed abscess of bone. The first stage of necrosis is attended with a good deal of constitutional disturbance, which measurably subsides upon the occurrence of suppuration, though occasional exacerbations may be observed during the whole process of exfoliation. During the second stage, the dead bone acts as a foreign body, keeping up the discharge, and furnishing the necessary irritation to effect its own separation, and to excite the osteogenetic function of the periosteum, by which the process of repair is chiefly accomplished. The *time required* for the separation of a necrosed portion of bone varies from a few weeks to many years: it is usually less for the upper than for the lower extremity, and, other things being equal, is proportionably shorter, as the necrosis is more circumscribed and superficial.

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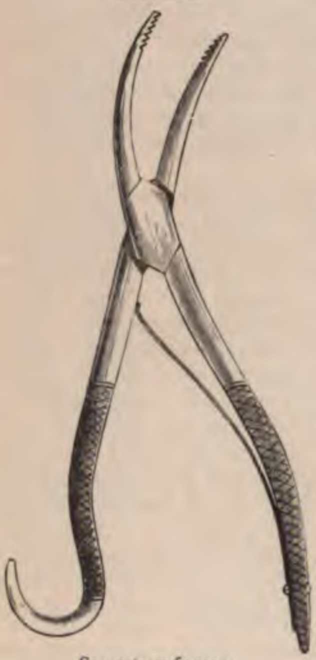
[1] This fact was long since observed by Copland Hutchison, and has more recently been noticed by Packard, Markoe, Demarquay, and other writers; but the true explanation appears to have been first given by Ollier, of Lyons (see pp. 225 *et seq.*).

[2] Necrosis without suppuration has been observed by Stanley, Paget, and Morrant Baker.

Prognosis.—The prognosis of necrosis, in the large majority of cases, is favorable. It is very seldom that the disease, attacking the shaft of a bone, extends beyond the epiphyseal lines, and, after the removal of the dead part, the repair will usually be found so complete as to preserve the utility of the limb. In some very acute cases, as in necrosis resulting from subperiosteal abscess, life may be endangered during the first stage of the affection, and at a later period death may occasionally occur from exhaustion or from pyæmia. The latter disease not unfrequently causes a fatal result in cases of moist necrosis. Special risks attend necrosis in certain situations; thus in the *skull*, there is danger of secondary meningitis or cerebral abscess; in the *ribs*, of empyema; and in the *patella*, of destructive inflammation of the knee-joint—while an exfoliation from the *posterior surface of the femur* may penetrate the popliteal artery and lead to fatal hemorrhage.

Treatment.—The treatment of the first stage of necrosis consists in endeavoring to moderate the inflammation upon which the affection depends, and in freely opening any abscesses which may form. During the time occupied by the loosening of the dead bone, no operative treatment is, as a rule, admissible, and the surgeon should content himself with such measures as may serve to maintain the patient's health. As soon as the necrosed portion has become detached (not before, unless in very exceptional cases), it should be removed, nature being rarely able to effect its extrusion—though occasionally (especially in children) a piece of dead bone will be found protruding from the soft parts, when it may be readily pulled away. In case of an *exfoliation* (if there is no invaginating sheath), it will be sufficient, when the bone is found by the probe to be loose, to divide the soft parts, and tilt up the detached fragment or scale from the subjacent granulations, by means of a director or elevator introduced beneath its edge—when the loose bone may be readily drawn away with forceps. If the necrosed bone be in the form of a *sequestrum*, the operation is more complicated: an incision should, in this case, be made down to the bone, in the line of the principal cloacæ, joining two or more of them, if there be several, in such a manner as to avoid the chief vessels and nerves. In some cases, if a cloaca be large, it may be possible to withdraw the sequestrum through it, dividing the dead bone, if necessary, into two portions by means of cutting-pliers previously introduced. The cloacæ may be enlarged with tre-

FIG. 276.



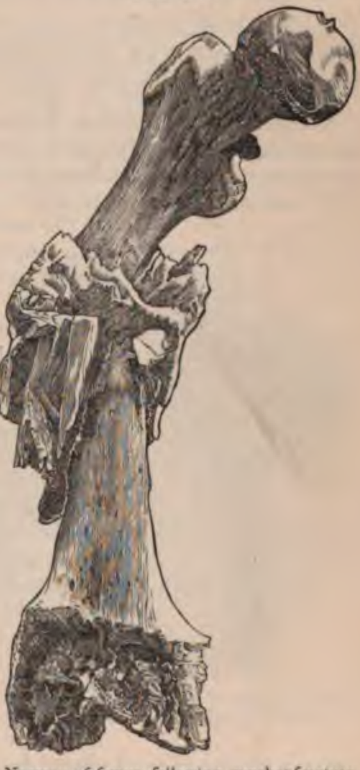
Sequestrum forceps.

phines or chisels, or the portions of new bone between them may be divided with Hey's saw, gouge-forceps, or strong cutting-pliers, the sequestrum being then drawn out with suitable forceps, whole or piecemeal, as the exigencies of the case may require. It is usually possible to determine beforehand that a sequestrum is loose by introducing a probe through a cloaca, or by introducing two probes through different openings, when a see-saw motion may often be detected. It sometimes happens, however, that at the operation the sequestrum is found to be only partially detached, bringing with it, when wrenched away, a portion of living and vascular bony tissue. The cavity left by the removal of a sequestrum is commonly lined by a layer of granulations—though in scrofulous cases a sequestrum may be surrounded with carious bone, which must then be removed with the gouge. The after-treatment consists in applying a light dressing, and in placing the limb, if the involucrum be thin, on a suitable splint, so as to prevent deformity from bending.

In *acute necrosis* resulting from subperiosteal abscess, when the whole diaphysis of a long bone has perished, Mr. Holmes and Giraldès recommend that the part should be removed as soon as the patient has rallied from the first shock of the affection. The operation, which has been successfully resorted to by Holmes, Letenneur, McDougall, Spence, Heath, Duplay, Weinlechner, Bockenheimer, Pye, and Shrady, requires a very free incision, dividing the periosteum which will be found entirely separated, the bone being then bisected with a chain-saw, and wrenched from its epiphyseal lines by means of the lion-jawed forceps (Fig. 302). The bone most commonly affected is the tibia, but Bockenheimer's operation was on the femur, and Shrady's on the humerus. Even if the limb be left perfectly flail-like at the time, it may be hoped that it will become consolidated, and ultimately useful.

The rule which has been given, not to operate in cases of necrosis until nature has effected the separation of the dead fragment, applies particularly to cases of ordinary *dry* necrosis. In the *moist* variety of the disease, should it be recognized during life, it would be, I think, right to attempt the removal of the dead bone at an earlier period. The risk of pyæmia would probably be thus lessened, while the condition of the patient could not be seriously aggravated.

FIG. 277.



Necrosis of femur, following gunshot fracture. (From a specimen in the museum of the Episcopal Hospital.)

Necrosis, affecting one of the spongy bones, as of the tarsus, or the articular extremity of a long bone, may require *excision* or possibly *amputation*. The latter operation may also become necessary if the disease be so situated that the sequestrum cannot be safely removed, as in the femur represented in the accompanying illustration, from a case in which my colleague, Dr. W. S. Forbes, amputated at the hip-joint; or amputation may likewise be required in any case, if life be endangered from exhaustion and long-continued suppuration.

NON-INFLAMMATORY STRUCTURAL DISEASES OF BONE.

Under this head may be enumerated Hypertrophy and Atrophy, Rickets, Osteomalacia, Tubercle, Scrofula, Syphilis, and various forms of Tumor.

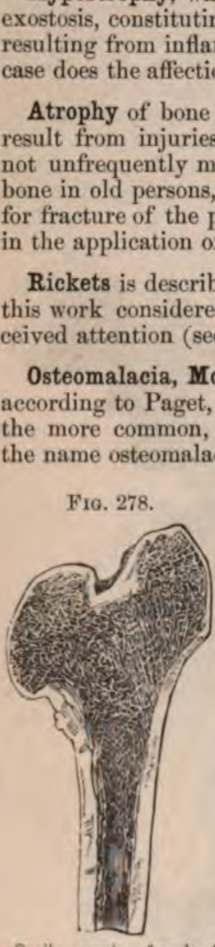
Hypertrophy, when not the result of inflammation, appears as a form of exostosis, constituting the variety known as *Osteoma* (see page 487): when resulting from inflammation, it receives the name of *Periostosis*. In neither case does the affection admit of treatment.

Atrophy of bone often occurs simply as a senile change, but may also result from injuries, as contusions or fractures, or from mere disuse. It is not unfrequently met with as the result of a fall, in the neck of the thigh-bone in old persons, where it gives rise to shortening, and may be mistaken for fracture of the part (Fig. 278). The only admissible treatment consists in the application of a high-soled shoe.

Rickets is described by many writers as a disease of the bones, but is in this work considered to be a general affection, and as such has already received attention (see page 429).

Osteomalacia, Mollities Ossium, or Fragilitas Ossium.—Two affections, according to Paget, appear to be included under these names; one, which is the more common, consists in fatty degeneration, and the other, to which the name osteomalacia should be strictly confined, consists in an absorption of the earthy constituents of bone, the part affected being more or less reduced to a cartilaginous state. The latter form of the disease attacks particularly the bones of the trunk, especially the pelvis (where in the female it may impede parturition), while the former is more common in the bones of the extremities. Several bones are usually affected.

FIG. 278.



Senile atrophy of neck of femur. (LISTON.)

The softening process begins at the centre and spreads outwards; the cancellous structure is dilated, its cells being filled with a red jelly-like matter, consisting of fat, oil, blood, and nucleated corpuscles. If the compact structure be not involved, the bone is rendered brittle and liable to fracture, as in remarkable cases reported by Tyrrell, Arnott, R. W. Smith, Joseph Jones, and Blanchard, of Chicago. If the whole thickness of the bone, on the other hand, be involved, it becomes pliable and easily bent, the most curious distortions resulting, as in the oft-quoted case of Madame Supiot. The disease seldom occurs in childhood, but usually in early adult or middle life; it is more common in women than in men, and often appears to have been induced by pregnancy or parturition. It is sometimes hereditary, and, according to Heitzmann, may like rickets be artificially produced by long administration of lactic acid. It is not uncommon among the insane.

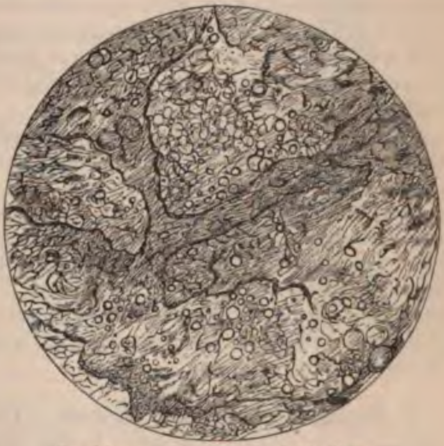
Symptoms.—The early symptoms are generally obscure, consisting chiefly in vague pains, which are probably considered rheumatic. Sometimes the giving way of the limbs, the bones being either fractured or bent, is the first circumstance which attracts attention. The *urine*, and sometimes the other secretions, contain an abnormal quantity of phosphates; and in a case recorded by Dr. MacIntyre, the urine contained also a large amount of animal matter of an albuminous nature. As the disease progresses, the patient becomes bedridden, and may remain in this state for many years, eventually dying from simple exhaustion, or from some independent affection: in other cases, the viscera may become fatally deranged by the pressure of the distorted bony parietes.

Diagnosis.—In its early stages, osteomalacia is liable to be confounded with *Rheumatism*, and the diagnosis may not be possible until the appearance of phosphates in the urine, and the morbid condition of the bones, reveal the nature of the affection. From *Rickets* it may be distinguished by observing that osteomalacia[1] is a disease of adult life, and rachitis of infancy. The tendency to fracture, which gives to the disease the name of fragilitas ossium, may likewise arise from simple *Atrophy*, or from *Cancer*. The former affection may be distinguished by investigating the history of the case, and the latter by observing the presence of carcinomatous disease in other parts of the body.

Treatment.—The treatment of this affection is as unsatisfactory as its pathology is obscure. The surgeon can do little beyond endeavoring to maintain the general health of the patient, to prevent the formation of bed-sores, and to relieve pain by the use of opium. The internal administration of *alum* appeared to produce temporary benefit in a case reported by MacIntyre.

Tubercle of bone is a rare affection—rarer probably than is usually believed—many cases of supposed tuberculous deposit being in reality instances of chronic inflammation, attended by the formation of pus which becomes inspissated, and undergoes cheesy degeneration (see page 426.) True tubercle does, however, apparently occur in bone, where it may be either circumscribed (*encysted*), or diffused (*infiltrated*). The circumscribed variety is the rarer, and occurs chiefly in the skull and the articular extremities of the long bones, especially the tibia; it produces no disturbance until softening occurs, when it leads to an intractable form of caries, and, if in the neighborhood of a joint, often involves the latter in a destructive form of inflammation. The diffused tubercle affects particularly the shafts of the bones, and is, according to Holmes, less apt to run into softening than the circumscribed variety.

FIG. 279.



Scrofulous osteitis; magnified 250 diameters. (ERICHSEN.)

Scrofula manifests its influence on the osseous system by predisposing to destructive inflammation and caries. *Scrofulous* differs from *Simple Osteitis* in its greater tendency to spread and to induce disorganizing changes, and in the absence or feebleness of the natural efforts at repair. The affected bone is soft, light, and oily, the proportion of fat and of soluble salts being increased, and that of calcareous matter and of the organic matrix markedly diminished. The symptoms of scrofulous osteitis are those of scrofula in general, superadded to a chronic and indolent form of bone inflammation. The *treatment* consists in the administration of remedies adapted to the scrofulous diathesis, with such local measures as may, if possible, prevent the occurrence of suppuration. After the subsidence of the acute symptoms, advantage may be often derived from pressure, applied by strapping the part with the compound galbanum or with soap plaster. Should suppuration occur, the resulting caries must be treated as directed in the preceding pages, it being remembered, however, that the prognosis of operations, in both scrofulous and tuberculous cases, is less favorable than when there is no constitutional taint (see pages 426 and 429).

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[1] Osteomalacia is sometimes called *Rachitis Adultorum*.

Syphilitic Affections of Bone have already been referred to at page 462.

Changes of Bone due to Affections of the Nervous System.—Blanchard has noted bone-changes in cases of locomotor ataxia; these consist essentially in a rarefaction, preceded by decalcification, of the osseous substance around the Haversian canals, and lead to the occurrence of spontaneous fractures. The change is identical with that observed in the epiphyses in cases of tabetic arthropathy.

Tumors in Bone.[1]—**1. Cystic Growths** in bone may occur as independent formations, or may be secondarily developed in solid tumors.

Serous and *Mucous Cysts* are met with in the jaws, and possibly in other bones. They form smooth, indolent tumors, and, when large, give a sensation of semi-fluctuation, with a peculiar crackling sound, from the thinning of their bony investment; the superficial veins are often enlarged and tortuous. The *treatment* consists in removing a portion of the wall with a trephine or otherwise, the cavity being then stuffed with lint, so as to induce contraction and healing by granulation.

Hydatids occurring in bone would closely simulate the simple cystic formations above referred to: the *treatment* should consist in excision or amputation, according to the part affected.

Sanguineous Cysts.—Travers excised the greater part of a clavicle on account of a cystic tumor containing blood. In most instances, sanguineous cysts appear in connection with solid growths, of a fibro-cellular, fibro-cartilaginous, myeloid, or malignant character. The *treatment* consists in excision or amputation, according to the situation and extent of the growth. Dr. Pierson, of Orange, N. J., has reported a remarkable case of sanguineous cyst of the sacrum.

2. Non-Malignant Solid Tumors.—The non-malignant solid tumors met with in bone belong ordinarily to the fibrous, cartilaginous, myeloid, sarcomatous, and osseous varieties. The symptoms and treatment of these various affections have been sufficiently considered in Chap. XXVI. A caution may, however, be here given as to the removal of a bony tumor from the neigborhood of a joint: in this situation, exostoses frequently induce repeated attacks of synovitis, which may leave the synovial sac so thickened and dilated, that it is exposed to injury in any attempt to remove the growth. Hence, it is better, as a rule, not to interfere with these tumors, unless in a locality in which no special risk can attend the operation. If an exostosis interfere with the usefulness of a part, an attempt may be made to break it off with strong pliers (the skin being protected with chamois leather), without making any external wound; such a plan was twice successfully adopted by the late Mr. Maunder. Should this fail, subcutaneous section with a saw or chisel would be the next best resort. In dealing with any non-malignant tumor of bone, *enucleation* may (as pointed out by Paget) be occasionally preferable to excision or amputation.

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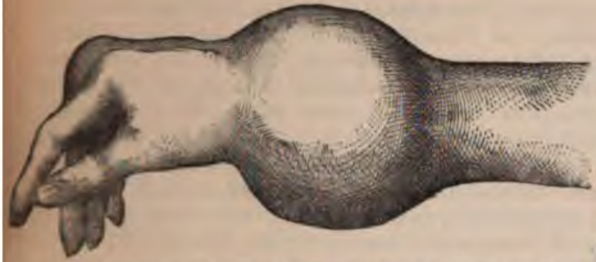
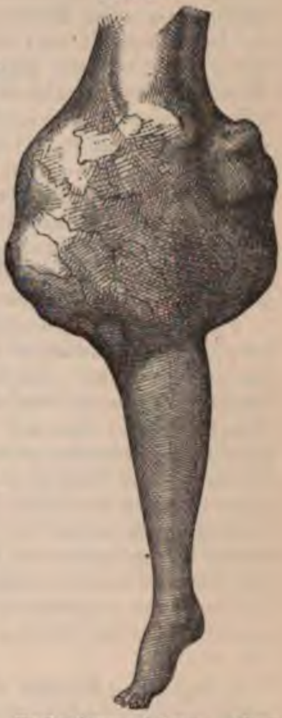
[1] Percussion is recommended by Lücke as a means of recognizing the presence of a tumor in bone, the morbid growth causing a lower resonance than in the normal condition.

FIG. 280.



Osteo-sarcoma of bones of forearm. (From a patient in the University Hospital.)

FIG. 281.



Enchondroma of femur. (From a patient in the University Hospital.)

3. Malignant Tumors.—Any form of malignant tumor may occur in bone, by far the most frequent, however, being the encephaloid, or medullary cancer. This may originate in the interior of a bone, when it is said to be *central* or *interstitial*, or may be primarily developed in and beneath the periosteum, when it is called *periosteal* or *peripheral*. In other instances it is said to be *infiltrated*, when the whole bone is softened and filled with cancerous material—a condition which, as already remarked, has been confounded with osteomalacia. The *central* or *interstitial* cancer occurs chiefly in the cancellated structure of the flat bones and of the articular extremities of the long bones, producing long-continued pain, and (if in a long bone) often predisposing to fracture. As the tumor increases in size, the bone wall undergoes expansion, becoming thinned, and crackling on pressure (whence the old name "*spina ventosa*"), until finally the morbid growth makes its escape, when it grows with renewed rapidity. The *peripheral* or *periosteal* cancer occurs principally in or beneath the periosteal covering of the shafts of the long bones, the bony tissue itself remaining comparatively free from disease, though it occasionally becomes softened, when fracture may occur. In this form of cancer, partial ossification not unfrequently takes place.

Symptoms.—The symptoms of cancer in bone are the presence of a rapidly growing lobulated tumor, elastic and semi-fluctuating to the touch, with sharp lancinating pains, and great distention of the subcutaneous veins. A thrilling pulsation, sometimes accompanied with a blowing sound, is occasionally perceptible. As the disease advances, the neighboring soft tissues and lymphatic glands become involved, while the "cancerous cachexia" is often rapidly developed.

Diagnosis.—Cancer occurring in bone is to be distinguished from *Abscess* by the history of the case, the lobulated character of the tumor, the absence of inflammatory symptoms, and, if necessary, by the employment of the exploring-needle. From partially consolidated *Aneurism*, and from *Aneurism by Anastomosis*, it may usually be distinguished by attention to the early history of the case, when this can be ascertained. From *Non-malignant Tumors*, especially the myeloid or enchondromatous, the diagnosis is often difficult, and may be occasionally impossible, except by the aid of a microscopic examination. It is right to add that, according to Thiersch, Waldeyer, and Billroth, true cancer never occurs in bone as a *primary* affection; either a preceding growth in some of the epithelial tissues has been overlooked, or the tumor on microscopic examination will be found to be a sarcoma and not a cancer. Maguire, of Manchester, has, however, collected 22 cases (including one of his own) in which the diagnosis of primary cancer of the femur seems to have been well established.

Treatment.—This consists in excision or amputation: *excision* is to be employed in the case of the flat bones (as the scapula), or those of the face (as the upper jaw), but is rarely justifiable if the disease have passed the limits of the bone itself, involving the soft structures or lymphatic glands. *Amputation* is commonly to be preferred in the case of the long bones, and should be performed at as early a period as possible. It is usually advised to remove the limb at or above the nearest joint, but it would appear from cases recorded by Collis, Pemberton, and others, that amputation in the continuity, or through the epiphyseal line, is sufficient; probably a safe rule would be, in the case of the forearm or leg, to remove the limb just above the elbow or knee, in that of the humerus at the shoulder-joint, and in that of the femur (unfortunately the most common of all), at as low a point as would insure the removal of the whole disease.

4. Pulsating Tumors of Bone.—Most of the pulsating tumors met with in bone are in reality of an encephaloid or myeloid character; some, however, are probably of the nature of aneurism by anastomosis, and still others, possibly, true aneurisms of the osseous arteries. The latter alone should receive the name of *Osteoid Aneurism*. The disease originates in the cancellated structure (usually the head of the tibia[1]), and gradually distends the compact wall, which becomes thin and yielding, crackles on pressure, and finally gives way. When fully developed, the affection is attended with a marked pulsation, usually accompanied with thrill: by compressing the main trunk, the pulsation stops, and the tumor may then be emptied by pressure, a cavity surrounded by a bony wall being perceptible. The pulsation may disappear when the resistance of the periosteum is overcome. The *bruit*, which is commonly distinct in pulsating encephaloid of bone, is often absent in the osteoid aneurism.

In the *treatment* of this affection the surgeon may (if the tumor be small and situated in one of the long bones) attempt *extirpation* of the growth with the knife, or, which is probably better, with caustics or the hot iron; if excision be practised, the surface of bone from which the disease springs should be likewise removed. *Ligation of the main artery* has been occasionally employed, but usually with only temporary if any benefit. If the disease be far advanced, or if other measures have failed, *amputation*, as in malignant disease, is the only resource.

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[1] Dr. Peugnet, of New York, has recorded a remarkable case of osteoid aneurism of the lower jaw.

Pulsating Tumors of the Cranial or Trunk Bones are almost invariably of an encephaloid character, and rarely admit of successful treatment.

CHAPTER XXXI.

DISEASES OF JOINTS.

THE older surgeons confounded together all diseases of the joints under the common names of *arthritis* and *white swelling*, and it is within a comparatively recent period only, and in a great measure through the labors of Sir Benjamin C. Brodie, that a more accurate classification has become possible. The tendency at the present day, as justly remarked by Holmes, is to run to excess in the other direction; and the student is apt to be confused by the minute divisions of systematic writers, and to be disappointed, on entering practice, to find that he is unable to discriminate between affections which are actually indistinguishable, and which in the large majority of instances really coexist in the same cases.

The various constituents of a joint, synovial membrane, cartilages, bony articulations, etc., are so intimately connected with each other, that a morbid condition of one is almost sure to involve the others secondarily. An exception should, perhaps, be made in the case of the synovial membrane, and I shall, therefore, in the following pages, first describe the affections which are limited to that tissue, considering, subsequently, those which involve the joints as a whole.

SYNOVITIS.

Inflammation of the synovial membrane may arise from traumatic causes, or from exposure to cold; it may be uncomplicated, may be modified by the patient's being of a scrofulous, rheumatic, or gouty diathesis, or may be a mere secondary occurrence in the course of puerperal fever, pyæmia, gonorrhœa, or syphilis. Simple or uncomplicated synovitis may be *acute* or *chronic*, the difference being comparative, and referring to the intensity of the affection, rather than to any specific diversity.

Pathology.—The first effect of inflammation on a synovial membrane is to produce increased vascularity, with a diminution of the natural shining appearance of the part. The amount of synovia is abnormally increased, being at first thin and serous, but subsequently cloudy, from the admixture of shreds of epithelium, inflammatory lymph, the coloring matter of the blood, and (if the disease be not checked) pus. In many cases, the disease terminates in resolution, the parts gradually resuming their natural state, or perhaps remaining somewhat thickened, where there is a liability to relapse: occasionally the joint is left distended by serous effusion, constituting the condition known as *Hydrarthrosis*, or *Hydrops Articuli*. In other instances, further morbid changes are observed: the synovial membrane assumes in parts an appearance of granulation, and, while the intra-articular effusion becomes purulent in character, the cartilages become involved and perforated by ulceration, until finally the articulating extremities of the bones themselves may become inflamed and carious. At the same time, the surrounding tissues, which at first were inflamed and infiltrated with lymph, undergo disorganization; abscesses form and make their way into the joint, or toward the surface, upon which they open by sinuous tracks: the ligamentous structures become elongated, thickened, and softened, and partial or complete dislocation may occur.

Symptoms.—The symptoms are usually well marked. There is *pain*, often accompanied by a feeling of distention, and usually referred to the affected joint, but occasionally to others: thus pain in the knee attends inflammation of the hip. The pain is increased by motion or pressure, is often worse at night, and in some cases (as in the synovitis of pyæmia) is attended by marked cutaneous hyperæsthesia. *Swelling*, varying with the amount of intra-articular effusion, is a characteristic symptom—the shape of the joint being altered by the distention of the synovial capsule. In the shoulder and hip, this alteration consists in a general enlargement of the part, while in the elbow the swelling is most marked on either side of the olecranon and beneath the tendon of the triceps, and in the knee on either side of the patella (which floats on the effusion) and beneath the tendon of the quadriceps femoris. *Fluctuation*, which is distinct in the early stages, when the effusion is of a serous character, becomes less so as the disease advances, from the production of inflammatory lymph and the infiltration of surrounding structures. *Heat* and *redness* vary according to the superficial or deep character of the joint, and the degree to which the superincumbent tissues are involved. The *position* in which the patient involuntarily places the joint is characteristic: in the early stages, this position is such as to allow the greatest mechanical distention of the synovial capsule, while at a later period it is determined by the weight of the limb, by the necessity of maintaining the joint in a fixed position and of preserving it from the pressure of external objects, and lastly by the neighboring muscles becoming fixed in the positions which they have been permitted to assume.

When synovitis ends in resolution, or subsides into a *chronic* state, the symptoms which have been described gradually pass away, the inflammatory fever (which runs high in the acute stage) diminishing, and the part gradually returning, more or less completely, to its normal condition. The *swelling* may, however, as already mentioned, persist in chronic synovitis, constituting *hydrarthrosis;* while in some cases a peculiar *crepitation* or *crackling* may be developed by moving the part, due apparently to the rubbing together of bands and adhesions which have resulted from the organization of inflammatory lymph.

The occurrence of *suppuration* in a joint (*pyarthrosis*) is marked by an increase of all the symptoms, and by the occurrence of rigors—while the accompanying inflammatory fever assumes a somewhat typhoid type. Abscesses form in the surrounding soft parts, the articular capsule gives way, and the contents of the joint are evacuated; recovery, if obtained at all, is effected by the obliteration of the articular cavity by a process of granulation and cicatrization, partial or complete stiffness or *anchylosis* resulting.

When the disease invades the articular cartilages and bones, passing in fact into what will be presently described as *Arthritis*, the pain becomes much aggravated, assuming a peculiar "jumping" or "starting" character (usually worst at night), and often accompanied by a distinct grating on rubbing the articulating surfaces together.

Treatment.—The *Constitutional Treatment* of synovitis presents no peculiarities requiring special comment, being essentially that directed in Chapter

II. for any case of severe inflammation. Rheumatic, gonorrhœal, or syphilitic complications require various modifications, according to the circumstances of the case. In the *Local Treatment* of synovitis (during the acute stage), great benefit will often be derived from the application of *dry cold*, in the form of Esmarch's ice-bag, or by the method of mediate irrigation (p. 55). In other cases, it may be better to surround the joint with a *warm poultice*, medicated with laudanum or hops; that application should be preferred which is most agreeable to the patient. In every case, the joint should be placed *at complete rest*, and in such a position as will secure the greatest usefulness should anchylosis occur. For this purpose the limb should be fixed upon a well-padded splint, or in a suitable fracture-box, the mechanical support being so arranged as to prevent even the slightest motion of the affected joint. *Continuous extension* may be employed, as recommended in the treatment of arthritis (p. 601), though its beneficial effects are, I think, less marked when the synovial membrane is alone involved than when all the tissues of the joint are implicated.

When the acute symptoms have subsided, absorption of effusion and restoration of function may be promoted by the repeated application of blisters or tincture of iodine, together with douches, frictions with stimulating embrocations, moderate pressure by means of a soap plaster and bandage, and the cautious employment of passive motion, if any tendency to stiffness be observed. Bergeret speaks highly of the use of *dry heat* applied by means of bags filled with hot sand. If the joint be left in a relaxed condition, the patient should continue to wear an elastic support for some time after recovery.

Hydrarthrosis or Hydrops Articuli (*Dropsy of a Joint*) is almost invariably a result of chronic synovitis; it would appear, however, from the observations of Richet and others, that it may occasionally occur as a primary affection. Hydrarthrosis is most common in the knee, and is occasionally seen in the elbow, but very rarely in any other joint. The effused fluid differs from ordinary synovia, resembling more the contents of a hydrocele, or the fluid met with in ascites. This affection is often associated with a gouty or rheumatic diathesis, and is apt to recur from very slight causes. The *treatment* (in the event of the failure of the ordinary remedies for chronic synovitis) consists in the injection of the tincture of iodine, either pure or diluted. A portion of the effused liquid should be first evacuated by means of an aspirator, or of a small trocar and canula introduced through a valvular incision; the iodine is then injected (not more than a fluidrachm of the tincture being used at once), and after remaining for a few minutes is again withdrawn, precautions being taken against the admission of air, and the wound being immediately sealed with collodion. Any inflammation which may result should be treated in the way already described. This mode of treatment has been used with great success by several European surgeons, and is favorably spoken of by Mr. Erichsen; as, however, the plan is necessarily attended with some risk, it should not be employed except in very chronic cases which have resisted other modes of treatment, and in which the distention of the joint is productive of great inconvenience. Even the simple use of the aspirator is in these cases attended with some danger, as shown by fatal results which have occurred in the hands of Dubreuil, and of McDonnell, of Dublin.

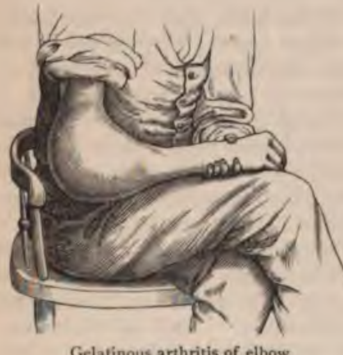
Pyarthrosis or Abscess of a Joint may, as has been mentioned, result from acute synovitis—or may accompany a more serious condition, such as arthritis, subperiosteal abscess, or osteo-myelitis—or may be a mere incident in the course of pyæmia. If the *diagnosis* of intra-articular abscess be not clear, the surgeon may, in the case of the superficial joints, satisfy himself as to the nature of the case by the use of an exploring or suction trocar. The *treatment* consists in evacuating the pus by means of a free incision, drainage being secured by position, or by the use of Chassaignac's tubes or Ellis's wire coil (see p. 392). In some cases, advantage may be derived from washing out the joint by injecting diluted tincture of iodine, or a weak solution of carbolic acid. In favorable cases, especially in children, recovery by anchylosis may be obtained; but should the strength of the patient begin to flag, no time should be lost in resorting to excision or amputation—the former operation being, under these circumstances, as a rule, applicable to the upper, and the latter to the lower, extremity. Death after pyarthrosis may result from simple exhaustion, or from the development of pyæmia.

ARTHRITIS.

By *Arthritis* is meant inflammation of a *joint as a whole;* whichever tissue may have been first attacked, the remainder are sooner or later implicated. Arthritis usually begins with inflammation of the synovial membrane, or of the articulating extremities of the bones; more rarely the ligaments and surrounding soft parts are first involved, but it is doubtful whether the articular cartilages are ever affected, except secondarily.

Gelatinous Arthritis.—The origin of arthritis in ordinary *Synovitis* has already been considered; there is, however, a form of chronic synovitis, called by Barwell *strumous*, and by Athol Johnstone *scrofulous*—but which, as justly remarked by Swain, may exist without any evidences of a scrofulous diathesis—in which the synovial membrane is found in a pulpy or gelatinous condition, and which almost invariably ends in destructive disorganization of the joint. This condition of the synovial membrane is described by Brodie and Swain as a peculiar form of degeneration, called by the former *pulpy*, and by the latter *gelatiniform, degeneration;* Barwell, on the other hand, regards it as essentially the same as the granulation change referred to in speaking of the pathology of synovitis in general, the difference being that, in ordinary synovitis, this granulation tissue undergoes further development, while in the cases now under consideration it remains in a rudimentary state. Godlee has studied the granulation tissue from these cases of "white swelling," and finds it to consist of cells and nuclei embedded in a trabecular meshwork with which "giant-cells" are connected by processes. In fact the appearances closely resemble those of miliary tubercle, and tend to confirm the view that tubercle is of inflammatory origin; similar observations have been made by Friedlander. As the disease progresses, the articular cartilages undergo a somewhat analogous change, the disease finally reaching the bones, which become softened and carious. The *symptoms* of this peculiar form of disease, which may be appropriately called *Gelatinous Arthritis*, and which is rarely seen except in

FIG. 282.



Gelatinous arthritis of elbow.

the knee and elbow, and in adults, differ from those of ordinary synovitis in several particulars. Thus the *swelling* is more diffused, and comparatively unattended with fluctuation, being of a doughy and somewhat elastic type—this elasticity, as pointed out by Fergusson, causing the bones, if pressed together, to resume their former position when the pressure is removed. The swelling is often accompanied, and partially masked, by general œdema of the limb. The *pain* is less marked than in synovitis, and of a dull, gnawing character, differing both from the acute pain of ordinary synovitis, and from the "jumping" pain which attends exposure of the bone by ulcerating cartilage. There is little or no *heat*, and if the part be at first *red*, the surface soon loses its color, often becoming eventually positively blanched—an appearance so characteristic as almost to justify the name of *white swelling* formerly given to these cases. Another point, to which Swain calls attention, is that considerable mobility of the joint often remains, even when the disease has reached an advanced stage.

Arthritis from Bone Disease, etc.—Arthritis begins, in many cases, with a morbid condition of the bones which enter into the formation of the joint—this condition consisting of diffuse periostitis (subperiosteal abscess), osteomyelitis, necrosis, caries, tuberculous deposit, or (which is probably the most common) a low form of osteitis of the articulating extremities, which is often described as strumous, but which has no necessary connection with the scrofulous diathesis (see page 425). Volkmann, however, regards a tuberculous deposit in the articular extremities as the most common cause of arthritis.

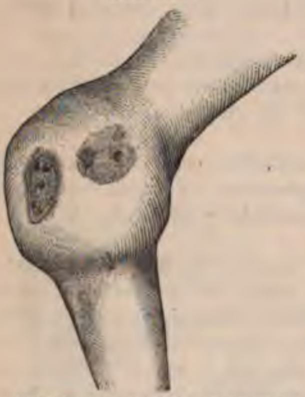
Arthritis may likewise begin with inflammation of the *Ligaments* and other peri-articular structures (as after sprains), and it may possibly, in some rare cases, originate in primary inflammation of the *Articular Cartilage.*

Causes of Arthritis.—Among the causes of arthritis may be enumerated wounds (see page 214), sprains, contusions, exposure to cold and moisture, pyæmia, the puerperal state, scarlet fever, the scrofulous diathesis, etc.

Symptoms.—The symptoms of arthritis are those of deep-seated inflammation; they often begin very insidiously, but when fully established are easily recognized. The *swelling* is more uniform than in synovitis, and doughy rather than fluctuating to the touch; the *pain*, which is specially referred in the case of the knee to the inside of that joint, and in the case of the hip to a point above and behind the great trochanter, is excessive, worst at night, aggravated by the slightest touch, or by motion of the part, and accompanied (when the disease is fully developed) by spasmodic contractions of the adjoining muscles, giving it the peculiar "jumping" or "starting" character which has been already referred to. These spasms occur particularly at night, coming on when the muscular system is relaxed by sleep, and often causing the patient to wake with a scream. These "jumping" pains have long been associated with ulceration of the articular cartilages, and were formerly supposed to be due to the condition of those structures; it is now, however, generally acknowledged that inflammation and ulceration of cartilage is not, in itself, attended with pain (cartilage containing no nerves), and that the peculiar starting pains of arthritis are really due to the condition of the plate of bone immediately beneath the seat of ulceration. When the cartilaginous disintegration has gone so far as to lay bare opposing surfaces of bone, they will rub together when the joint is moved, and distinct *grating* may thus be produced. The *position* assumed by the patient, in a case of arthritis, is quite characteristic: the affected joint is so placed as to enable it to be kept fixed, and to be most thoroughly relaxed; thus, in the case of the knee, the patient lies on the affected side, with the outside of the joint resting on the bed, the leg flexed on the thigh and the thigh on the pelvis—the opposite knee drawn up so as to serve as a guard, and to keep off the weight of the bedclothes—and the whole attention apparently concentrated and directed to shield the diseased part from injury. The *inflammatory fever* is severe, assuming a typhoid type if suppuration occurs, and perhaps yielding to hectic in the advanced stages of the disease.

The symptoms which accompany the occurrence of *suppuration* in cases of arthritis are very much the same as were described in speaking of pyarthrosis from synovitis. *Pointing* sometimes takes place at a comparatively early period, but in other cases the pus, after escaping from the cavity of the joint, dissects up the muscular interspaces of the limb for some distance before making its appearance on the surface. Occasionally many of the symptoms of suppuration may have been present, including even absorption of the cartilages and relaxation of the articular ligaments (as shown by unnatural mobility, or the occurrence of dislocation), and distinct grating on motion, and yet recovery may ensue under judicious treatment, without any discharge of pus, though with more or less complete anchylosis. In these cases the pus, or at least its fluid portion, has probably been absorbed, the pus corpuscles undergoing fatty or calcareous degeneration. It is in such cases as these that *residual abscesses* are sometimes observed after considerable intervals of time (see p. 393). When arthritis of a *large* joint, as the hip or knee, has advanced to the stage of abscess, the prospects of spontaneous recovery are usually very limited. In some cases, particularly among those whose social condition secures to them careful nursing, abundant nutriment, opportunity for change of air, and other favoring circumstances, a cure by anchylosis may be obtained, the opposing joint surfaces becoming united by granulations which are subsequently organized into a fibrous or imperfect bony tissue; but in most instances, and as a rule with hospital patients, unless rescued by operation, such cases eventually terminate in death from exhaustion, diarrhœa, or pyæmia, or from phthisis, or other diseases of internal viscera. Arthritis of the *smaller* joints offers a much more favorable prognosis. *Elongation of the affected limb* is occasionally observed in arthritis as the result of irritation of the epiphyseal cartilages, but in most cases the disease ultimately leads to shortening and withering of the part.

FIG. 283.



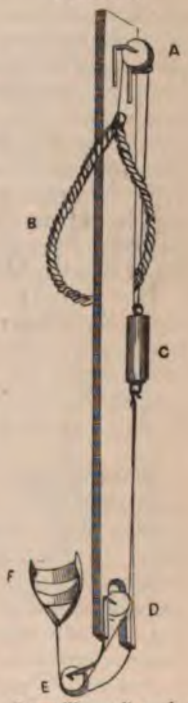
Arthritis of knee-joint, in an advanced stage. (From a patient in the Children's Hospital.)

Acute Arthritis of Infants.—T. Smith has described under this name a very severe form of the disease met with during the first year of life. The affection, which is not dependent upon the presence of a syphilitic taint, is a very fatal one, thirteen out of twenty-one cases, recorded by Mr. Smith, having ended in death. When recovery occurs there is little risk of anchylosis, but the joint may be weakened by the loss of portions of bone. Two cases of recovery are recorded by Morrant Baker. Amputation has been successfully employed by G. Brown.

Treatment.—The *Constitutional Treatment* of arthritis consists pretty much in the administration of anodyne diaphoretics, with occasional mild laxatives, during the acute stage—followed by tonics, especially iron and cod-liver oil, at a later period. Mercurials, which may be proper in traumatic arthritis, should be used, if at all, with great caution in these cases—medicines of any form being, indeed, of less importance than nutriment, which should be given abundantly and in an easily assimilable form.

The most important part of the *Local Treatment* is to place the joint in a state of complete and long-continued *rest*, aud in a favorable *position*. If the *shoulder* be affected, the arm should be kept to the side, and directed somewhat forwards, while the *elbow*, if diseased, should be maintained in a *flexed*, and the *wrist*, *hip*, or *knee* in a *straight* or *extended* position. In all cases in which the lower extremity is involved, the foot should be properly supported, so that when recovery is obtained the patient may not be left with a *pes equinus*. It is recommended by many excellent authorities, that if the limb be found in a vicious position, it should be forcibly placed right, while the patient is under the influence of an anæsthetic, any resisting muscles or tendons being subcutaneously divided if necessary. I think, however, that the object may be, in many cases, quite as well and more safely accomplished by the use of continuous extension, applied by means of elastic bands, or, which is more convenient, by means of the ordinary weight-extension apparatus (see Fig. 127). When the limb has been brought into the proper position, it should be fixed, with well-padded splints or fracture-boxes, or, if the surgeon prefer, with some form of immovable apparatus, an aperture being cut so as to allow of inspection and topical medication of the joint. In many cases of arthritis, particularly if affecting the knee or hip, the greatest advantage may be derived from the use of *continuous extension*, which may be applied with Barwell's splint, in which the extension is effected by an India-rubber *accumulator;* with a spiral wire spring surrounding the limb, as suggested by Holthouse; or (which I prefer) with the ordinary weight-extension apparatus—a mode of treatment which was used by Brodie, and which has been since successfully resorted to by numerous surgeons. The efficacy of this simple apparatus may be still further increased by the application of lateral long splints or sand-bags. An ingenious splint for making extension in cases of arthritis of the wrist has been devised by Fagan, of Belfast. The relief from pain afforded by continuous extension in cases of joint disease is very marked. It appears to act by counter-acting the tendency to muscular spasm, and thus preventing the inflamed ends of bone from being pressed together.

FIG. 284.



Barwell's splint for making continuous extension.

With regard to *topical medication* in cases of arthritis, the best application during the acute stage is, I think, usually a warm poultice, though in some instances dry cold appears to afford more relief. Leeches may be required in some cases. When the first acute symptoms have subsided, benefit may often be derived from counter-irritation in the form of blisters, or the actual cautery. The cautery should be applied *before* the occurrence of suppuration (the patient being anæsthetized), by drawing the iron, heated to a black heat only, rapidly across the joint, in lines at least an inch apart; it is not necessary to produce a slough, and the surrounding parts may be protected (as recommended by Voillemier) by coating the whole with collodion, the cautery thus only affecting the part which it absolutely touches. Nélaton suggests the use of a metal ruler as a guide to the lines in which the cautery is to be applied. The hot iron, though doubtless an efficient remedy, is one to which all patients have a feeling of revulsion, and should, therefore, I think, be reserved for very urgent cases. *Blistering* I have usually found quite satisfactory; the blister should be placed over the seat of greatest pain, and it is better to use a *small* than a large blister, repeating it if necessary. In the chronic stages, great advantage may be derived from painting the part with iodine, and from the use of pressure applied by means of a soap plaster and firm bandage. Marshall speaks very favorably of the application of a solution of the oleates of mercury and morphia in oleic acid, while Barwell employs, in the gelatinous form of the disease, injections of diluted tincture of iodine (one part to fifteen), not into the joint, but into the thickened surrounding tissues. Injections of carbolic acid have been tried, and sometimes with benefit, by Knörr, Hueter, Petersen, Schmidt, and other surgeons. Le Fort injects a ten per cent. solution of sulphate of zinc, with one-fourth part of alcohol. If *suppuration* occur, the case must be treated by free incisions, etc., as directed in speaking of pyarthrosis; if the bones be but slightly involved, recovery may still be sometimes obtained by perseverance in conservative treatment, but under opposite circumstances excision or amputation will usually be indicated, if the joint be so situated as to admit of operative interference. Fitzpatrick, of Dublin, speaks favorably of the application of the potassa-cum-calce to the affected tissues, but a case thus treated by Mr. Holmes ended fatally through the development of pyæmia. The local use of sulphuric acid has proved successful in cases reported by J. W. Haward and other surgeons, and Mr. G. A. Wright has effected a cure by laying open the joint and scraping away the diseased structures. In cases of *gelatinous arthritis*, the chances of spontaneous recovery are so slight that excision is indicated at a comparatively early period.

The account which has been given above of arthritis in general will suffice for a description of the affection as met with in most of the articulations, as the shoulder, elbow, wrist, knee, ankle, tarsal joints, etc. There are, however, two situations in which arthritis occurs, which impress certain peculiarities on the disease, requiring more detailed consideration; these are the hip and the sacro-iliac articulation.

Arthritis of the Hip-joint, Morbus Coxarius, Coxalgia, or Hip Disease, is an affection of early life (more than two-thirds of all cases occurring in persons under fifteen years of age), and is much commoner in boys than in girls.[1] Three varieties of the disease are recognized by Erichsen, according as it begins in the head of the femur, the acetabulum, or the proper structures of the joint (especially the synovial membrane); and this division being, in some respects, convenient, I shall follow that author in speaking of *femoral*, *acetabular*, and *arthritic coxalgia*.

Nature.—The nature of hip disease has been a matter of much dispute, many distinguished surgeons looking upon it as almost always, if not invariably, a constitutional affection, depending upon a tuberculous or scrofulous diathesis. The remarks made in a previous chapter upon struma are particularly applicable here; while it is probable that, in a few cases at least, a deposit of tubercle does lead to hip disease, and while there can be no doubt that the scrofulous diathesis does act as a predisposing cause of the affection, there can be as little doubt, I think, in the light of modern pathology, that many if not most cases are simply of an inflammatory nature; and that, in a majority of instances, the disease is to be looked upon as having a local origin, and (which is of the highest importance, in a practical point of view) as specially demanding local treatment.

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[1] Of 100 consecutive admissions for hip disease into the Children's Hospital of this city, 61 were of boys and 39 of girls. Again, of 419 cases of excision for hip disease collected by Culbertson, in which the sex of the patient was ascertained, 297 were in males, and 122 in females.

Causes.—The exciting causes of hip disease are usually of an apparently trivial character, such as slight blows or falls, sprains, over-exertion in walking, or sitting on cold steps, or in wet grass.

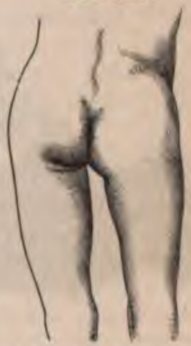
Symptoms.—The symptoms of the affection vary in its different *stages*, three of which are commonly described by surgical writers. Hip disease usually begins very insidiously, obscure pains, which are probably considered rheumatic, and a limping or shuffling gait, often existing for some time before any deformity is discovered.

(1.) *Pain* is felt in the affected joint and in the corresponding knee, the latter symptom being most marked in the *femoral* form of the disease, and apparently due to irritation of branches of the anterior crural and obturator nerves. The pain in the hip is constant in the *arthritic* form, of a very acute type, and accompanied with a feeling of tension, and with tenderness above the great trochanter. It is increased by motion or exercise, and is, therefore, worse in the evening, but the "starting" pains caused by muscular spasm do not come on until a comparatively late period. In the *femoral* and *acetabular* varieties, the hip pain is of a dull, gnawing character, worse at night, often intermittent, and specially elicited by striking on the knee or heel, and thus pressing the joint surfaces together; starting of the limb is developed at an early period. Of course, as the disease advances, in whatever form it may have originated, the different symptoms become merged together, so that these distinctions are only available in the earliest stage of the affection.

(2.) *Swelling* is most marked in the *arthritic* variety, which may be looked upon as the acute form of the disease. *Redness* and *Heat* are rarely observed in any case on account of the deep situation of the joint.

(3.) *Deformity.*—In the *first stage* of hip disease, the knee is slightly flexed, and the limb usually but not always abducted—this position being involuntarily assumed, as most easy to the patient. Slight *limping* accompanies this stage of the disease. The *second stage* is marked by *flattening of the buttock*, the fold of the nates on the affected side becoming almost if not quite obliterated; with this there is *elongation of the limb*, which in the large majority of cases is apparent merely, being due to a twist of the pelvis, though in the arthritic form of the disease there may possibly be in some instances true elongation, from distention of the synovial capsule. When in this stage the patient stands, the whole weight is borne by the sound limb, that which is diseased being carried forward, flexed, and abducted. If now he be placed in the recumbent posture, the limbs may be brought to the same level, the deformity apparently disappearing; but by careful examination it will be found that the relative position of the thigh and pelvis is the same as in the standing posture, the lumbar spine being unduly arched,

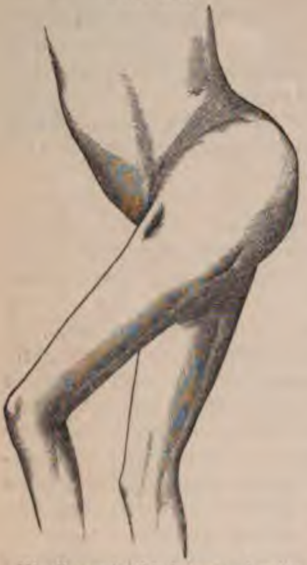
FIG. 285.



Hip disease in *second* stage; showing flattening of buttock, with apparent elongation. (From a patient in the Children's Hospital.)

and the pelvis distorted into an abnormally vertical position. In this stage there is marked lameness, and it is to this stage also that the pain in the knee particularly belongs. In the *acetabular* variety of the disease there is comparatively little deformity, while in the *femoral* there may be, as long as the patient is going about, apparent *shortening* (due to distortion of the pelvis), which, however, yields to apparent *lengthening* after a few days' rest in bed. The deformity of the *third stage* (between which and the second there may be an interval of comparative comfort, consists in *adduction* of the limb (Fig. 286), leading to *shortening*, which is greater in appearance than in reality, with undue *prominence* of the buttock on the affected side, marked obliquity of the pelvis, and a compensatory double lateral curvature of the spine. The *rima natium*, which in the second stage inclined *towards* the affected side (Fig. 285), is now directed *away* from it. The *shortening* of the third stage of hip disease is, at the beginning of that stage, merely *apparent;* as the malady progresses, however, actual shortening occurs, from alteration in the shape of the bones which enter into the formation of the joint (Fig. 287), and in some cases, though in fewer than was formerly supposed, from positive dislocation taking place. The deformity of the *first* and *second* stages is, according to Verneuil, due to inflammation of the muscles in proximity to the joint—the psoas and lesser gluteals; at a later period these undergo atrophy, and the deformity of the *third* stage is caused by inflammation of the adductors and sartorius.

FIG. 286.

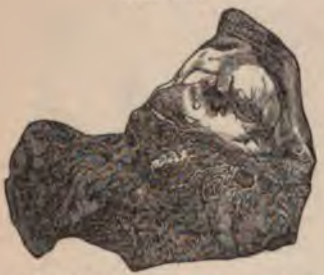


Hip disease in *third* stage; showing shortening and adduction, with obliquity of pelvis. (From a patient in the Children's Hospital.)

(4.) *Dislocation* is chiefly confined to the *femoral* variety of the disease, and its occurrence is often attended with marked relief from pain; if, as sometimes happens, it takes place without the previous formation of abscess, a new socket may be developed upon the dorsum ilii, the acetabulum becoming gradually filled up and obliterated. In the *acetabular* form of the affection the cotyloid cavity may become perforated, the head of the femur perhaps slipping through into the cavity of the pelvis.

(5.) *Suppuration* may or may not occur in the *arthritic* form of hip disease, but is almost inevitable in the other varieties. It occurs earlier in the *acetabular* than in the *femoral* form of the affection. The spot at which *pointing* occurs is often significant; thus an abscess opening on the outer part of the thigh, below the trochanter, indicates disease of the caput femoris, while abscesses opening in the pubic region denote disease of the acetabulum—the abscess being intra- or extra-

FIG. 287.

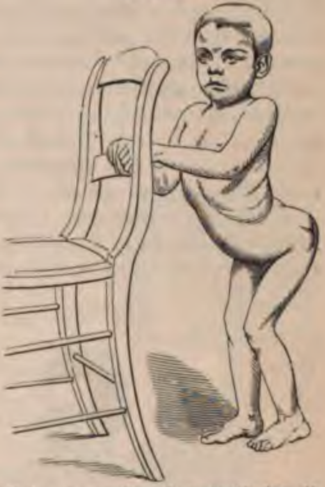


Excised head and neck of femur; showing change in shape of bone in third stage of hip disease (see Fig. 286). (The specimen is in the Mütter Museum of the College of Physicians of Philadelphia.)

pelvic according as it opens above or below Poupart's ligament. Abscess opening in the gluteal region may indicate either form of the affection.

Termination of Hip Disease.—The *arthritic* and occasionally the other forms of the disease, if submitted to judicious treatment at an early period, may terminate favorably, though in many cases the best that can be hoped for is a cure by *anchylosis*. Even if the joint be anchylosed, provided that the limb have been kept in a straight position, the result will be quite satisfactory, the mobility of the pelvis compensating in a great degree for the stiffness of the joint; but unless precautions have been taken in regard to position, anchylosis with great deformity will ensue, such distortion as is exhibited in the accompanying cut (Fig. 282) being by no means unfrequently met with. If suppuration have occurred, and therefore we may say as a rule in cases of *acetabular* or *femoral coxalgia* (particularly if followed by consecutive dislocation), the utmost that can usually be attained by conservative measures is recovery with a shortened, deformed, atrophied, and often useless limb. Death may occur from simple exhaustion, diarrhœa, tuberculosis, amyloid degeneration, or pyæmia, or from some intercurrent affection which would have been successfully resisted but for the constantly depressing influence of the joint affection.

FIG. 288.



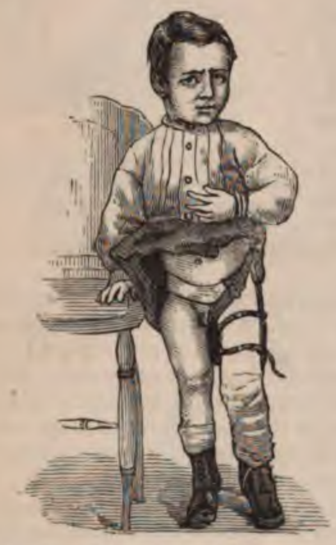
Deformity resulting from double hip disease. (From a patient under the care of Dr. Hodge, in the Children's Hospital.)

Diagnosis.—Hip disease may be distinguished from *rheumatism* by observing the limitation of the affection to one joint, and by noting the characteristic deformity. This may be readily made apparent, as pointed out by Prof. Sayre, by placing the patient upon a perfectly hard plane surface, when, if the knee of the affected limb be brought down, the lumbar spine instantly becomes arched. From *lateral curvature of the spine* with neuralgic tenderness, it may be distinguished by the pain being increased by pressing together the joint surfaces, and by the existence of painful nocturnal spasms, while the diagnosis from *antero-posterior curvature of the spine* may be made by observing the mobility of the hip in that disease, and the different seat of pain—though if the abscess in spinal disease point on the outer side of the thigh, pressing on filaments of the obturator nerve, there will be pain referred to the knee, just as in hip disease. Morbus coxarius could only be mistaken for *abscess external to the joint*, for *disease of the knee*, or for *caries of the great trochanter*, by neglect of careful examination; and I am disposed to say the same in relation to *perityphlitis*, which, according to Dr. Gibney, is not unfrequently mistaken for hip disease. From *sacro-iliac disease*, the diagnosis may be made by observing that in that affection the seat of greatest tenderness is different, that there is no shortening, and no pain on moving the hip *if the pelvis be fixed*, and that the pelvic distortion is permanent and absolute, not, as in hip disease, temporary and relative. The diagnosis from *separation of the upper epiphysis of the femur* with abscess, is difficult, if not impossible—a matter which, fortunately, is of no practical moment, as excision would be equally indicated in either affection.

Prognosis.—Statistics are wanting to show the mortality of hip disease, it being but seldom, from the chronic nature of the affection, that the surgeon has the opportunity of watching a case to its termination. My own impression is very decided, that, when suppuration has occurred, the bones being involved, recovery without operation is an extremely rare occurrence: this impression is confirmed by the results of 9 terminated cases observed by Gibert, which gave 8 deaths and but 1 recovery. It is true that hip disease does not appear very frequently in our mortuary records, but this is owing to the fact that the patients are carried off by secondary complications or intercurrent affections, to which the death is attributed—no reference being made to the chronic condition, without which those affections would not have occurred, or would not have proved fatal. *Femoral*, and still more *acetabular*, coxalgia may be therefore looked upon as extremely grave diseases; the *arthritic* form of the affection, however, offers, as already mentioned, a much more favorable prognosis.

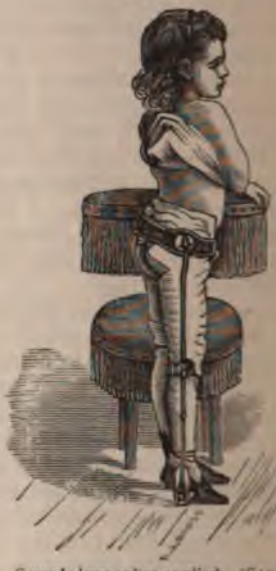
Treatment.—It is very important that *early* treatment should be adopted in every case of hip disease, and accordingly a rigid examination of the case should be instituted on the slightest suspicion of the existence of this serious affection. During the *first* stage of the disease, the patient should be put to bed, and the joint kept in a state of complete rest by the use of extension, and, if needful, the adaptation of a suitable splint. I myself employ an ordinary long splint, well padded, or sand bags, as in the treatment of fractured thigh, but the surgeon may use with equally good results the carved splint of Dr. Physick, or one moulded from gutta-percha, leather, or pasteboard, or splints made from wire gauze, as recommended by Barwell and Bauer, or finally any of the forms of immovable apparatus which were described at page 82. The particular form of splint used is a matter of indifference, provided that the limb be kept in a proper position, and the joint in a state of *absolute rest*. To relieve pain, especially the starting pain which is one of the most distressing symptoms of the affection, *continuous extension* is the most valuable agent which we possess. The ordinary weight-extension apparatus may be used, as in cases of

FIG. 289.



Sayre's short splint applied. (SAYRE.)

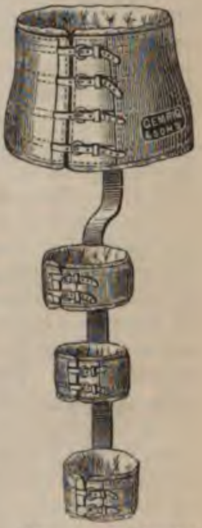
FIG. 290.



Sayre's long splint applied. (SAYRE.)

fractured thigh, or Barwell's elastic "accumulator" may be employed instead. The simple weight is the most convenient means, and is, according to my experience, very efficient. J. Wood employs *double* extension, a weight being attached to each limb and counter-extension made by raising the foot of the bed. I have not, myself, found it necessary to resort to subcutaneous division of the tendons or spasmodically contracted muscles, an operation which has, however, been successfully employed by Bonnet, Bauer, Sayre, and other surgeons. If the affection have run on to the second stage, the same treatment is to be employed, together with counter-irritation by blisters or the cautery, applied to the seat of greatest pain, usually a little above and behind the great trochanter; the general condition of the patient must at the same time receive attention, the state of the digestive organs being looked to, and the strength maintained by the administration of food and tonics, especially iron and cod-liver oil.

FIG. 291.



Agnew's modification of Thomas's apparatus for coxalgia. The splint is applied to the affected limb, a high-soled shoe placed upon the opposite foot (sound limb), and the patient required to use crutches.

In most cases of *arthritic* coxalgia, and in some at least of the *femoral* variety, if the treatment above described be early adopted and strictly carried out, a marked improvement will soon be manifested, the pain and tenderness gradually disappearing, till at length motion of the joint is no longer productive of suffering, and the patient feels and considers himself well. The time required for this favorable evolution of events is of course variable, six or eight weeks being probably a minimum period. If now all further treatment be neglected, the disease will in a short time almost inevitably recur, and probably in an aggravated form; and yet it is very important that the patient should be no longer confined to bed, but should be enabled to take exercise in the open air. It is in these circumstances, I think, that the ingenious forms of apparatus devised by Davis, Sayre, Andrews, Taylor, Thomas, of Liverpool, Agnew, and other surgeons, are particularly serviceable: they act by keeping up extension and counter-extension, while the patient is enabled to walk about and lead a comparatively active life.[1]

In the *third* stage of the disease, the treatment already advised is still applicable, extension being here particularly indicated, in order to prevent or counteract the tendency to shortening. If *abscess* form, the same plan may still be continued, counter-irritation being, however, now abandoned as useless. If the abscess originate *within the synovial capsule*, distending and threatening to rupture the latter, the pus may be evacuated by means of an aspirator, or simple trocar and canula, with precautions against the entrance of air, as advised by Dr. Bauer. Under other circumstances, the abscess should, I think, be treated on the general principles laid down at page 393. It is rarely possible to effect the absorption of pus under these circumstances, but the attempt is worth making, and will occasionally succeed—as in a case mentioned by Barwell, and as in one under my own care in which absorption occurred under the influence of dry cold.

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[1] Dr. J. C. Hutchison, of Brooklyn, simply applies a patten to the *sound* limb, and puts the patient on crutches, believing that sufficient extension is produced by the weight of the affected member itself. The same method of producing extension is adopted by Thomas and Agnew, but, by their instruments, they secure immobility of the joint at the same time.

After abscesses have opened in cases of hip disease, leaving sinuses which lead down to carious bone, it is still possible in some instances to obtain a cure by anchylosis, and, in cases not admitting of operation, this is the best termination that can be hoped for. Little can be done, under these circumstances, beyond keeping the limb straight, moderately extended, and with the foot well supported, while the strength of the patient is maintained by appropriate constitutional and hygienic treatment. In many of the cases however, which reach this condition (at least among the class of children that come into our city hospitals), excision, or possibly amputation, may afford a better chance of life than perseverance in expectant treatment.

Arthritis of the Sacro-Iliac Joint (**Sacro-Iliac Disease**).—This affection, which is extremely fatal, is fortunately rare, though probably not quite as rare as is commonly supposed—being sometimes not recognized by practitioners, as indeed it has, until comparatively recently, been commonly ignored by systematic writers. It has been particularly studied by Nélaton and Erichsen. Sacro-iliac disease is an affection of early adult life, and usually begins with a condition analogous to, if not identical with, that form of arthritis which has been called *gelatinous*, though, in other instances, the bones appear to be first affected. The disease can seldom be traced to any definite exciting cause.

The *Symptoms* consist of *pain and tenderness*, with *swelling* over the line of the sacro-iliac junction, the pain being aggravated by motion, laughing, coughing, straining at stool, etc., and accompanied by a peculiar sensation, as if the body was falling apart. Pain is elicited also by pressing the sides of the pelvis together. The patient is *lame* from the beginning; and, as the disease advances, becomes completely bedridden, usually lying on the unaffected side. The limb on the diseased side is commonly *extended*, *elongated* from downward displacement of the os innominatum, and *wasted* from atrophy of its muscles. It is sometimes markedly *œdematous* from obstruction of the iliac vein. The *hip* is *deformed*, from the side of the pelvis being tilted forwards and rotated downwards. *Suppuration* occurs at a rather late period of the disease, abscesses pointing, according to Erichsen, over the joint, in the gluteal or lumbar regions, within the pelvis, or in connection with the rectum. In a case which was under my care at the Episcopal Hospital, abscesses pointed in the groin, in the gluteal region, and on the inside of the thigh.

The *Diagnosis* of sacro-iliac disease can usually be made without much difficulty, the affection with which it is most likely to be confounded being *hip disease*, the diagnostic marks of which have already been pointed out. *Disease of the spine* may be distinguished, even if there be no posterior curvature, by the presence of tenderness in the region of the affected vertebræ, and of stiffness of the whole spinal column, with absence of any elongation of the limb, or sign of disease about the sacro-iliac joint. *Neuralgia of the hip* may be distinguished by the diffused and superficial character of the pain, and by the absence of any real displacement of the os innominatum; while *sciatica* may be recognized by the seat of pain being below the sacro-iliac joint and extending down the limb, and by the absence of elongation or other signs of articular disease.

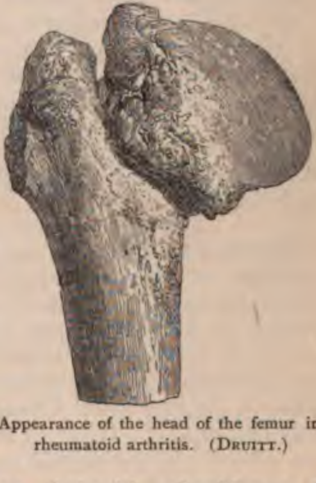
The *Prognosis* of advanced sacro-iliac disease is always unfavorable; Erichsen, who has devoted special attention to the subject, says that he has never seen recovery in any case in which the disease was fully developed, and in which suppuration had occurred. When seen at an early stage, however, there is more hope of successful treatment, and cases of recovery under these circumstances have been reported by McGuire and other surgeons.

The *Treatment* consists in endeavoring to prevent suppuration, by placing the joint at rest by means of the weight-extension apparatus, as advised by Prof. McGuire,[1] and at a later period by supporting the part with a leather or pasteboard splint, moulded to embrace the pelvis, hip, and thigh; counter-irritation may be of service in the early stage, and the general health should be sustained by the administration of cod-liver oil and other tonics. The patient should of course stay in bed, and preferably in the prone position. No operation is, for obvious reasons, admissible in this grave affection.

RHEUMATOID ARTHRITIS.

Rheumatoid Arthritis is the name proposed by Dr. Garrod for a peculiar form of inflammation of the joints, which was described by Adams, R. W. Smith, and Canton, as *Chronic Rheumatic Arthritis*, and which, in the case of the hip, is sometimes known as *Morbus Coxæ Senilis*. The *pathology* of this disease is involved in much obscurity; rheumatoid arthritis resembles both gout and rheumatism, and yet does not appear to partake of the nature of either of those affections. It probably begins with hyperæmia of the synovial membrane and increased synovial secretion, followed by thickening, and sometimes elongation, of the ligaments, gradual absorption or ossification of the inter-articular cartilages, and finally porcelanous induration and eburnation of the bony extremities. Barwell, however, believes that osteitis is the primary condition, and that the synovial change is entirely secondary. In the case of the hip, which is the joint most commonly affected, the round ligament disappears, and the head of the bone becomes irregularly enlarged, flattened, sometimes enlongated, and placed at a right angle with the shaft. The cervix femoris becomes shortened, apparently by interstitial absorption, and is often surrounded by vascular fringe-like projections of the synovial membrane. The acetabulum becomes enlarged, and sometimes flattened, but in other cases deepened, so as to surround the head of the femur as with a cup. Extensive stalactitic bony outgrowths often appear about the base of the great trochanter, and especially along the inter-trochanteric line, while similar osteitic formations are developed in the ligamentous and other soft tissues. On section, the bone is found to be rarefied, with an excess of oily matter—in a state, indeed, of osteoporosis with eburnation. All the joints of the skeleton may be involved, but those in which the disease is most commonly observed, are the articulations of the hip, shoulder, and lower jaw. Rheumatoid arthritis of the shoulder is, according to Canton, the true pathological condition in those cases described by Soden and others as displacement of the long head of the biceps. The joints on either side are often symmetrically affected.

FIG. 292.



Appearance of the head of the femur in rheumatoid arthritis. (DRUITT.)

Rheumatoid arthritis usually occurs in the male sex, and in persons who have passed the middle period of life; when met with at an earlier age, the patients are generally females; the disease appears in most cases to result from the action of cold in persons of debilitated constitution, the development of the affection in any particular joint being sometimes hastened by traumatic causes.

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[1] J. Wood employs *double extension*, as in cases of hip disease.

Symptoms.—The disease begins with pain of a rheumatic character, increased, in the case of the hip, by standing or walking, and followed by impaired power of motion, preventing the patient from either standing erect, stooping, or sitting in the ordinary posture. The limb may at first appear lengthened, but subsequently becomes shortened from changes in the shape of the bones, the apparent shortening being still further increased by obliquity of the pelvis. The limb is somewhat flexed and everted, the buttock becoming flattened, while the trochanter is unduly prominent and thickened. Crackling, or grating, may be elicited by rotating the limb, being evidently produced by the stalactitic formations already referred to, and by the rubbing together of the eburnated surfaces of bone. The muscles of the thigh waste, but those of the calf of the leg maintain their nutrition; the loss of motion in the hip is in some degree compensated for by increased mobility of the lumbar vertebræ. Suppuration occasionally, but very rarely, occurs, nor, according to Barwell, is there any tendency to the production of anchylosis.

Diagnosis.—Rheumatoid arthritis is chiefly interesting to the surgeon in a diagnostic point of view, being frequently mistaken for fracture in the neighborhood of the affected articulation. The diagnosis can usually be made by inquiring into the history of the case, and by observing that the affection is not limited to a single joint. The *arthropathies*, or articular affections which depend upon lesions of the nerves and nerve-centres, locomotor ataxia, etc., present many analogies to rheumatoid arthritis, and, according to Mitchell, are often clinically indistinguishable therefrom. The rapid wearing away of the articular extremities in tabetic arthropathy is the diagnostic feature chiefly relied upon by Charcot and Buzzard.

Prognosis.—The disease is very seldom fatal, but, on the other hand, is extremely chronic and intractable, and productive of a great deal of pain and discomfort.

Treatment.—But little can be done in the way of treatment, beyond the employment of ordinary hygienic means and the administration of tonics, especially cod-liver oil, iron, and quinia, the affected joint being, during the acute stage, kept at rest, and occasionally blistered. Iodide of potassium may be sometimes used with advantage, as may be arsenic and guaiacum. R. W. Smith speaks highly of the latter drug, in combination with sulphur, rhubarb, alkalies, and aromatics. Change of air, and a resort to various mineral springs, may be properly advised in some cases. With regard to motion of the diseased joints (in the chronic stage), it may be said that the patient may take as much exercise as can be done without inducing an aggravation of pain. Erichsen recommends, in the case of the hip, external support by means of lateral irons, jointed opposite the articulations, with a pelvic band and leather socket for the thigh and leg. *Excision of the hip* has been resorted to in this affection, but is not to be recommended; the prospective benefits of the operation, under these circumstances, are not sufficient to compensate for the risk which would necessarily attend its performance.

PERIARTHRITIS.

This name is applied by Duplay and Gosselin to a condition simulating arthritis, but due to inflammatory changes in the neighboring bursa and other periarticular tissues. There is less swelling and constitutional disturbance than in inflammation of the joint itself, and the diagnosis from rheumatism may be made by observing that but one joint is affected, and from neuralgia by noting a peculiar crackling which may be commonly detected by palpation of the affected bursæ. The treatment in the acute stage consists in the enforcement of rest, with the use of cataplasms, or belladonna and mercurial ointment, and at a later period in friction with stimulating liniments, and the employment of passive motion to prevent the occurrence of false anchylosis.

ANCHYLOSIS.

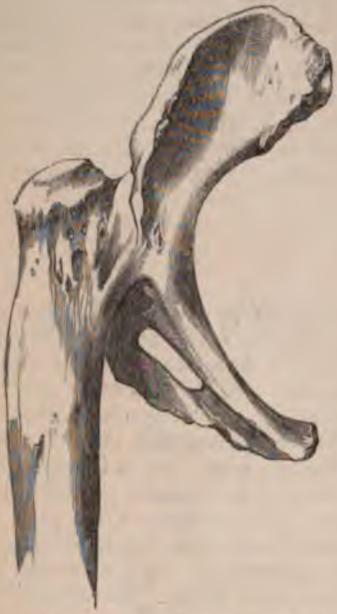
Frequent reference has been made in the preceding pages to the cure of joint-diseases by *anchylosis*, a word which, as used by surgeons, is equivalent to *stiff-joint*. *Anchylosis*, or *ankylosis* (the latter is etymologically the more correct spelling), may be *incomplete* or *complete*. In *incomplete* or *fibrous anchylosis*, the stiffness is due to thickening of the joint capsule, with the development of bands of fibro-cellular material which cross from one articular surface to the other, and which result from the organization of inflammatory lymph, or of the granulation structure which in joint-diseases replaces the synovial membrane and articular cartilages. The stiffness of the part is further promoted by contraction and adhesion of the neighboring muscles and tendons, the latter being almost exclusively concerned in the production of the so-called *false anchylosis*, which results from mere disuse. In *complete* or *bony anchylosis* the joint may be entirely obliterated, the articulating surfaces being united throughout by bone (*synostosis*), or (which is probably the more common condition) there may be fibrous anchylosis, with the superaddition of osseous arches or bands, which cross from side to side externally to the joint, and which may be new formations, of the nature of exostoses, or may result from the deposit of ossific matter in ligaments or other pre-existing soft structures. *Bony* anchylosis is rarely met with except as the result of *traumatic* arthritis, fibrous anchylosis being more common in the ordinary forms of the disease, particularly in patients of a strumous diathesis. It not unfrequently happens, indeed, under the latter circumstances, that, while more or less perfect anchylosis is taking place in one part of a joint, caries or necrosis is in existence at another. In *bony* anchylosis there is absolutely no motion of the joint, while in the *fibrous* variety slight motion may always be elicited by careful examination, particularly if the patient be in a state of anæsthesia.

Treatment.—The treatment of anchylosis varies according as it is *complete* or *incomplete*, and according to the *position* in which the joint has become stiff.

1. *Fibrous Anchylosis in a Good Position.*—No treatment should be adopted under these circumstances until all *acute inflammatory symptoms* have subsided; when the disease has become chronic, *passive motion* may be cautiously employed, being aided by frictions, the salt douche, etc. In fibrous anchylosis of the *elbow*, the patient may himself practise passive motion by swinging a flat-iron or other weight, as advised at page 230. Advantage is occasionally derived from the use of well-padded splints, the angle of which may

be varied by means of a Stromeyer's screw or other similar contrivance, or from the use of continuous extension by elastic bands or by a weight. It may be, in some rare cases, justifiable to attempt subcutaneous division of the restraining intra-articular bands, but the operation is not very promising, and is necessarily attended with some risk. Fibrous anchylosis of the *shoulder* is often followed by the development of a bursa beneath the scapula, the motions of which bone give rise to a crackling sound, described by Terrillon under the name of subscapular friction.

FIG. 293.



Synostosis of hip-joint. (PIRRIE.)

2. *Fibrous Anchylosis in a Bad Position.*—If the elbow be anchylosed in an extended position, or the shoulder, knee, or hip at a right angle, it becomes important to adopt more active treatment, though no operation should be performed until acute symptoms have passed away. In many cases, particularly in those of rheumatic origin, it is possible at once to restore the limb to a position in which it will be useful, by *forcibly flexing and extending the joint*, and thus rupturing the intra-articular adhesions, while the patient is in a state of anæsthesia. In other instances, *continuous extension*, by means of elastic bands (Fig. 296), or a weight, will be safer[1] and equally efficient. If resistance be made by contracted tendons in the neighborhood of the joint, these should be subcutaneously divided, a few days being then allowed to elapse before the employment of extension. Any inflammation which follows these manœuvres must be treated upon general principles. In the case of the hip-joint, subcutaneous osteotomy, by Adams's or Gant's method, may often be resorted to. The deformity met with in anchylosis following arthritis of the knee-joint usually consists in flexion, backward displacement of the tibia upon the condyles of the femur, and outward rotation of the leg and foot. In these cases, simple extension, even with division of the hamstring tendons, is not sufficient, the backward displacement persisting, and rendering the limb weak and comparatively useless; under such circumstances, the ingenious apparatus of Mr. Bigg (Fig. 297) may be employed, which acts by means of springs, drawing the head of the tibia downwards and forwards, while the condyles of the femur are at the same time pressed upwards and backwards. Subcutaneous division of the adhesions uniting the femur and patella is suggested by Mr. Willett, and has been advantageously resorted to by Mr. Maunder. Anchylosis of the knee in a position of *over-extension* is extremely rare; it is well seen in the accompanying illustration (Fig. 294), from a patient under my care in the Episcopal Hospital. The displacement in these cases is an exaggeration of that which is commonly observed, the head of the tibia slipping entirely

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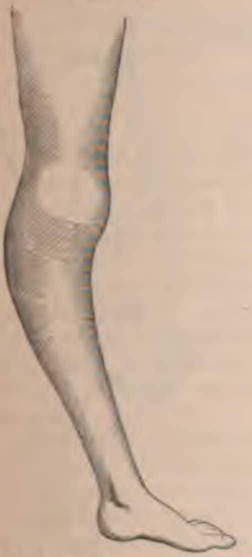
[1] The humerus has been fractured in attempting forcibly to break up adhesions of the elbow-joint, and Louvrier and Homans have recorded ruptures of the popliteal artery in similar operations for anchylosis of the knee.

behind the femur and projecting in the popliteal space. In cases of partial *fibrous anchylosis*, complicated by frequently recurring inflammation of the joint (Fig. 295), excision or amputation will not unfrequently be required.

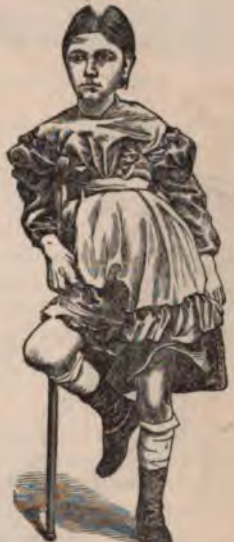
3. *Bony Anchylosis in a Good Position.*—If a joint be affected with bony anchylosis, and in such a position as to retain the usefulness of the limb, prudent surgery would dictate that no operation should be resorted to; an exception may be occasionally made in the case of the *elbow*, which may be in some instances advantageously excised under these circumstances. P. H. Watson and Annandale prefer to an ordinary excision of the elbow, a partial operation in which the lower portion of the humerus only is removed.

FIG. 294.



Anchylosis of knee-joint in position of over-extension. (From a patient in the Episcopal Hospital.)

FIG. 295.



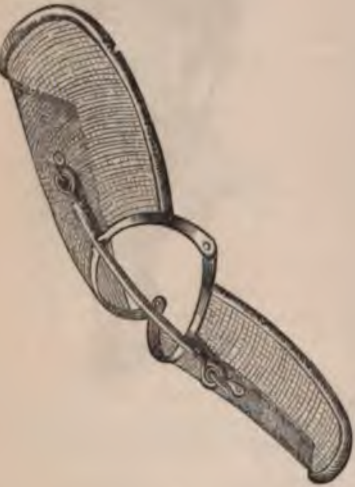
Chronic arthritis of knee-joint, with partial anchylosis in bad position. (From a patient in the Episcopal Hospital.)

4. *Bony Anchylosis in a Bad Position.*—Various operations have been employed to remedy bony anchylosis under these circumstances.

Hip.—Dr. J. Rhea Barton, of this city, in the year 1826, treated a case of osseous anchylosis of the hip by sawing through the femur between the trochanters, thus allowing the limb to be brought into a straight position; the patient recovered, as was anticipated, with an artificial joint, which remained movable for several years. This operation is often said to have consisted in the excision of a wedge-shaped piece of bone, but a reference to the original account of the case shows clearly that but one section was made with the saw. In 1830, Dr. J. Kearney Rodgers, of New York, improved upon Barton's operation by removing a disk of bone from between the trochanters, the portion exsected being half an inch thick at its outer, and three-quarters of an inch thick at its inner, side; the operation proved successful, the mobility of the new joint persisting after two and a half years.

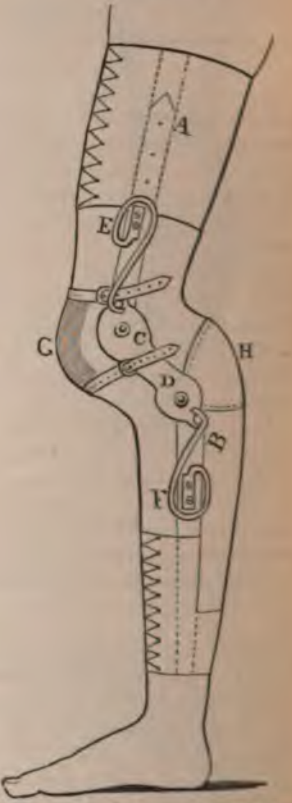
In 1862, Dr. Sayre, of New York, still further improved upon Rodgers's procedure, by removing a segment of bone from between the trochanters, the upper section being *semicircular*, with its concavity downwards, and the upper end of the lower fragment being rounded off, so as to imitate as closely as possible the natural form of a ball-and-socket joint. Dr. H. Leisrink has tabulated ten cases, in which one or other of these operations was resorted to, which, with Barton's original case, one referred to by Mr. Holmes, and others in the hands of Textor, Post, and Peters, of New York, and Walter, of Pittsburg, who has operated on both hips of the same patient, give seventeen operations (on sixteen persons), of which seven are known to have proved fatal — a mortality which, though large, is less than has followed excision of the head of the femur for anchylosis, two out of four cases of the latter operation having terminated in death.

Fig. 296.



Barwell's splint for making continuous extension in cases of anchylosis of knee.

Fig. 297.



Bigg's apparatus for contraction of the knee.

W. Adams has recently suggested a return to Barton's method, the section, however, being through the *neck* of the bone, and the operation being *subcutaneous*, while no attempt is made to secure a movable joint: the operation thus modified has been performed, according to Mr. Adams, in thirty-three cases, only three of which terminated fatally, and one of these after amputation of the hip-joint. This procedure, therefore, though inferior to Sayre's as regards the ultimate result,[1] when that is successful, seems to be less dangerous than any of the other methods which have been proposed, and should be preferred in most cases, particularly as the mobility of the pelvis compensates in a great degree for the loss of a movable articulation. Tillaux reports a case successfully treated by fracturing the neck of the femur, and Gant, Maunder, and other surgeons, have successfully divided the thigh-bone *below* the lesser trochanter—Gant with a saw, and Maunder and his followers with chisels. Barwell employs a chain-saw, and divides the bone *between* the trochanters, as in Barton's original method. I have myself employed either Adams's or Gant's operation in seven cases (in one case upon both sides, Figs. 299, 300), and in every instance with a favorable result. The choice between the operations should depend upon the condition of the articulation; when the cervix femoris is not materially altered in form, Adams's plan may be preferred, but in other cases section below the trochanter is better, and may be safely employed even in cases of fibrous anchylosis in strumous subjects. Barton's operation has been, according to Chelius, successfully employed (by Van Wattman) in a case of bony anchylosis of the *elbow*, and a similar procedure, or, which would be better, subcutaneous section, as practised by Mears for old dislocation, might be properly resorted to, if it should be necessary to interfere in a like condition of the *shoulder*.

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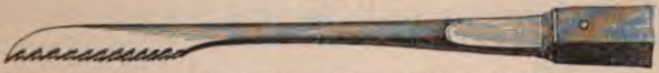
[1] In Sands's, Jessop's, and Lund's cases, however, movable joints were obtained.

FIG. 298.



Adams's saw for subcutaneous division of the neck of the femur.

Knee.—Barwell recommends (in case of bony anchylosis of the knee) that, in persons under fourteen years of age, advantage should be taken of the fact that the upper epiphysis of the tibia is, at this time of life, not yet united to the shaft, to straighten the limb by producing an epiphyseal fracture—the upper truncated end of the diaphysis then resting against the angular edge of the epiphyseal end, and the limb being shortened by little more than an inch. This mode of treatment is, according to Barwell, quite satisfactory and entirely free from risk. In a case of bony anchylosis of the knee, in a bent position, Dr. J. Rhea Barton, in 1835, removed a wedge-shaped piece of bone from the front of the femur, immediately above the condyles; the portion of bone did not involve the entire thickness of the shaft, the posterior shell of bone which was left, slowly yielding as the limb was, subsequently, gradually brought into an almost straight line. The result was entirely satisfactory, the thigh becoming firmly united in its new position. In 1844, Dr. Gurdon Buck, of New York, modified this procedure by exsecting a wedge-shaped mass embracing the entire thickness of the bone, and containing the condyles of the femur, head of the tibia, and patella, performing, in fact, what has since been called "excision *in a block*." In 1853, the same surgeon, in a case of fibrous anchylosis, substituted for the removal of a wedge-shaped mass, an ordinary excision of the knee-joint, the parts being subsequently held together with silver wire. Culbertson has collected fourteen cases of Barton's operation, to which should be added three others (successful) by Blackman, of Ohio, J. E. Adams, of London, and Kilgarriff, of Dublin, making in all seventeen cases with two deaths, while one or other of Buck's methods appears, according to the same author, to have been employed thirty-nine times with five deaths—the mortality of the former operation being thus 11.8, and that of the latter about 12.8, per cent.[1]

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[1] Another successful case, operated on by Buck's first method, has recently been recorded by Dr. T. G. Morton.

A safer method consists in subcutaneously perforating the anchylosed joint in various directions by means of a suitable drill (Fig. 110), the remaining bony adhesions being then forcibly ruptured, and the limb being, after a few days, gradually brought into a straight position by an extending apparatus. This operation appears to have been first suggested by Malgaigne, who proposed to use a chisel and mallet (as has since been done by L. S. Little and Maunder), though Dieffenbach had previously suggested separation of the united joint by means of a chisel and saw—not, however, used subcutaneously. Brainard, of Chicago, in 1854, proposed to apply the drill *to the bone immediately above the joint*, and the first operation upon this plan was performed by Pancoast, of this city, in 1859. Brainard subsequently applied the drill to the knee-joint itself, and the operation has since been repeated upon several occasions by Prof. Gross and others. Nine cases, collected by S. W. Gross in 1868, had proved uniformly successful. This procedure is certainly preferable to any other that has as yet been proposed, being not only attended with less risk to life, but having the great advantage of not shortening the limb by the removal of any portion of bone. In a case of great deformity of the knee from injury, without, however, complete anchylosis, I divided the femur just above the condyles with Adams's saw, and then, having straightened the limb, put it up in plaster of Paris. The result was in every respect satisfactory.

Fig. 299.

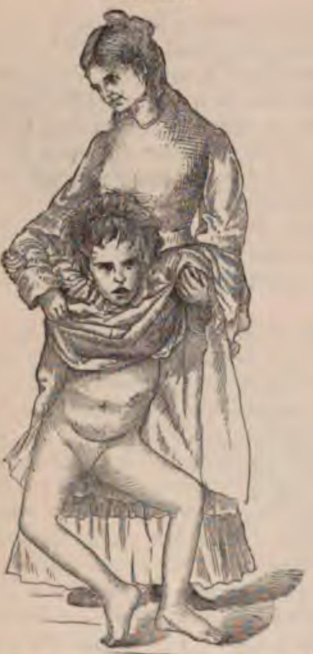
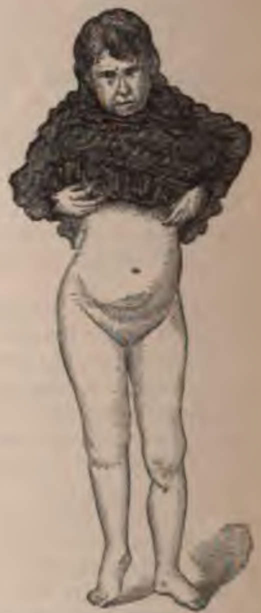


Fig. 300.

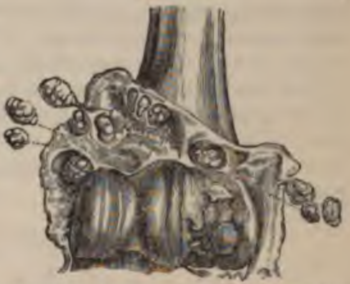


Subcutaneous osteotomy of both thigh bones for anchylosis following hip-disease. (From a patient in the Children's Hospital.)

LOOSE CARTILAGES IN JOINTS.

The name "loose cartilage" is given to certain bodies which are met with in joints, and which are very analogous to the rice-like bodies described as occurring in compound ganglia, and in diseases of synovial bursæ. These loose cartilages have, according to Rainey, as quoted by Barwell, a distinct investing membrane of a fibro-cellular character, and are found on section to consist of two layers, one fibro-cartilaginous, and the other resembling bone. They appear, in most instances, to originate in a tranformation of the villous or fringe-like processes of the synovial membrane, being thus at first attached by narrow pedicles to the parietes of the joint, but subsequently often becoming isolated. They are, according to R. Adams, especially met with in cases of rheumatoid arthritis, and are most common in the knee, though occasionally seen in other joints. Usually quite small and round, they are sometimes found as large as a chestnut, and flattened or elongated. They may be single, or may coexist in large numbers. According to Teale and Paget, these bodies are in some cases actually fragments of articular cartilage, which are separated by a slow process of exfoliation following necrosis, the result of injury.

FIG. 301.



Trochlea of humerus; showing formation and connection of loose cartilaginous bodies. (MILLER.)

Symptoms.—If closely attached, these bodies may give rise merely to weakness of the jöint, with a tendency to intra-articular effusion, but if floating or loose, they are apt to be caught between the opposing joint surfaces—this occurrence causing intense pain, sometimes accompanied with nausea or syncope, and the patient being unable to move the joint, and sometimes falling, while rapid synovial effusion commonly supervenes. These symptoms, it will be seen, closely resemble those of *dislocation of the semilunar cartilages* (see page 301).

Treatment.—This may be palliative or radical. The *palliative* treatment consists in supporting the joint by means of an elastic bandage, so as to restrain its motion and lessen the risk of the loose body becoming caught between the articulating surfaces. Hilton advises that the loose cartilage should be fixed in contact with the synovial membrane, by means of adhesive strips applied externally, when absorption of the foreign body may often be obtained. The *radical* treatment, which consists in removing the foreign body, either by direct or by subcutaneous incision, is attended with considerable risk to life, the mortality of the direct operation being, according to H. Larrey's and Barwell's statistics, 18, and of the subcutaneous procedure 8, per cent. Hence neither should be employed, unless the disease be attended with so much suffering as to make interference absolutely necessary. The direct operation consists in making a sufficiently free incision over the loose cartilage, which is firmly fixed between the surgeon's finger and thumb, the skin being drawn to one side so as to make a valvular opening, as recommended by B. Bell. The loose cartilage is then squeezed out through the cut, which is immediately closed, while the limb is kept at rest upon a splint.

Any inflammation which may follow is to be treated upon the principles already laid down.[1] The *subcutaneous* operation, which, though much safer, is more difficult and more likely to result in failure, consists in fixing the loose cartilage as before, and dividing the synovial membrane over it with a long tenotome passed subcutaneously beneath the skin; the foreign body is then squeezed into the periarticular areolar tissue, where it may be left to be absorbed, or from whence it may be removed by direct incision, after some days' interval, as advised by Goyrand. Another plan, introduced, and successfully practised in 25 cases, by Square, of Plymouth, is to squeeze the loose cartilarge into, but not through, the subcutaneous opening in the synovial membrane, fixing the foreign body in that position by means of a compress and adhesive strips. The point at which the incision is to be made, in the case of the knee, which is the joint usually affected, is to the inner side of, and a little below, the patella. If the cartilage cannot be fixed by the surgeon's fingers, MacCormac's plan may be adopted, and the offending body transfixed with a needle or fine trocar. If there be more than one loose cartilage, it may be necessary to repeat the operation at a subsequent period.

ARTICULAR NEURALGIA.

(*Hysterical Joints.*)

Intense pain in a joint may arise from various causes unconnected with disease of the articulation itself. Thus, pain in the knee is, as we have seen, a common accompaniment of hip disease, and the same symptom may arise from other circumstances, as the pressure of a tumor or an aneurism. Occasionally, however, intense neuralgic pain is felt in a joint, accompanied perhaps with slight swelling and redness, and attended with spasmodic action or, more often, rigid contraction of the neighboring muscles, and yet not dependent upon any perceptible organic change. These cases are chiefly, though not exclusively, met with in women, and usually in those who present other evidences of hysteria. The credit of first forcibly directing the attention of surgeons to the true nature of these cases is undoubtedly due to the late Sir Benjamin C. Brodie, and the subject has been since ably illustrated by Sir James Paget, who describes these, and similar cases, as instances of *neuromimesis* or *nervous mimicry* of disease. The joints most often affected are the knee, hip, and ankle, though a similar condition is occasionally seen in the elbow and shoulder, and perhaps in the vertebral column.

Diagnosis.—The diagnosis from arthritis may be made by observing the diffused and superficial character of the pain and tenderness, which are not increased by pressing together the joint surfaces (as would be the case in arthritis), and are not attended with the other signs of inflammation, and with the constitutional disturbance, which would be present in an ordinary case of joint-disease. The rigid contraction will often disappear, if the patient's attention be suddenly called away, and if an anæsthetic be given, the motions of the limb will be found to be unimpaired.

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[1] When performed with the precautions of Lister's antiseptic method, the risks of this operation are, according to Barwell and Barton, reduced to a minimum. Eighteen cases treated in this way, collected by J. H. Morgan, all terminated successfully. Gaujot, however, finds that 29 cases operated on with Listerian precautions gave two deaths, while 18 cases treated without antiseptic measures gave only one death.

Treatment.—This consists in the adoption of measures to improve the state of the patient's general health, particularly by attention to the digestive functions, and by the use of tonics and antispasmodics, with the cold douche and frictions to the affected joint. If contraction exist, the limb may be straightened while the patient is in a state of anæsthesia, and may be kept for a few days subsequently upon a suitable splint. Moral treatment is quite as important as physical, and the patient should, if possible, be induced to co-operate with the surgeon in the adoption of the means employed to promote recovery. In the belief that the disease is mental, it is sometimes advised to work upon the patient's imagination by pretending to perform an operation for her relief; though such a course may occasionally succeed, I believe the surgeon will do better, in the end, by dealing perfectly honestly with his patient, and avoiding even the appearance of deception. It is almost needless to say that such heroic measures as amputation or excision, or even the application of the actual cautery, would be totally unjustifiable in the cases under consideration. Meyer recommends the application of an induced current of electricity to the affected joint.

CHAPTER XXXII.

EXCISIONS.

Excision in General.

The operation of *resection*, in cases of compound fracture and dislocation, appears to have been known to the ancients, but subsequently was entirely forgotten until revived in the first half of the last century by Cooper, of Bungay, who removed the lower ends of both tibia and fibula for compound dislocation of the ankle. The first excision for *disease of a joint* appears to have been that performed by Filkin, of Norwich, in 1762, in a case of arthritis of the knee. The history of the introduction of the operation of excision into the practice of surgery, is a subject of much interest, but cannot be entered upon within the limits of this work; the reader is respectfully referred, for information upon this matter, to the able monograph of O. Heyfelder, and to that of Hodges, of Boston. The applicability of excision to the various *traumatic* lesions of bones and joints, and to *deformity* resulting from anchylosis, has already been considered in previous chapters (see pp. 166, 214, 613): and I shall therefore, in the following pages, confine myself to a description of the operative procedure in the different regions of the body, and to a consideration of the applicability of excision to *diseases* of bones and joints, especially to caries and arthritis.

Indications for, and Contra-indications to, Excision in General.—1. *Excision is indicated* (1) in case a bone or joint is so extensively diseased that its removal is imperative; here the question is between amputation and excision, and the latter operation should always be preferred, provided that the circumstances of the particular case admit of a choice.

(2) Excision is sometimes justifiable where the amount of disease is not sufficient to warrant amputation, and yet where the *time* which would be required for a spontaneous cure would be so long as to render operative interference proper, or where the utility of the limb would be less after a spon-

taneous cure than it would be after removal of the joint; as in the elbow, where a cure by anchylosis would be particularly undesirable.

2. *Excision is, on the other hand, contra-indicated* by (1) the extent of diseased bone being so great that its removal would render the limb an incumbrance, and less useful than a well-formed stump; this is particularly the case in the lower extremity, but in the arm, provided that the hand be preserved, very considerable portions of bone may often be properly removed.

(2) Excision should not as a rule be practised in cases of *acute disease*, experience showing that amputation is under such circumstances better tolerated. Hence, if operative interference be necessary to preserve life, in a case of acute bone or joint disease, amputation will usually be indicated: excision of the shaft of a bone may, however, be occasionally proper in cases of acute necrosis from subperiosteal abscess (see page 589).

(3) If the soft tissues around a diseased bone or joint be extensively diseased, infiltrated with lowly organized lymph, and riddled with sinuses, the result of an excision is less apt to be satisfactory than under opposite circumstances, though the operation is not absolutely contra-indicated by such a condition.

(4) Either extreme of life is considered unfavorable to excision, on account of the long period required for recovery after the operation, and, in the case of early childhood, on account of the risk of interfering with the growth of the limb, which is chiefly dependent upon the integrity of the epiphyseal cartilages. Boeckel, of Strasburg, however, from an examination of over twenty cases of arrested development,[1] concludes that the shortening is less due to injury of the epiphyseal cartilages than to disuse of the limb owing to pain or to muscular atrophy—causes which would be equally active if excision were not performed. This is confirmed by my own observation in a case of disease of the knee of twenty-three years' duration, in which the leg was by measurement four inches shorter than its fellow; by excising the joint and straightening the limb, which was much contracted, though a considerable portion of bone was of course removed, I gave the patient a limb which was practically two inches longer than it had been before the operation.

(5) A bad state of the general health, particularly if dependent upon organic visceral disease, as of the lungs, liver, or kidneys, must always be considered a contra-indication to excision. The long confinement which usually follows the operation, with perhaps long-continued and exhausting suppuration, will seriously complicate the chances of recovery in such a case. Hence, if any operation at all be required in a patient suffering from advanced phthisis, or from Bright's disease, amputation will usually be the preferable procedure.

From the above remarks, it will be seen that, while excision is, in suitable cases, an admirable and truly conservative operation, and in every way superior to amputation, yet it is, after all, only applicable in selected cases; hence it is obviously unfair to attempt, as has been sometimes done, to prove that excision is a less fatal operation than amputation, by a comparison of the statistical results of the two procedures—one being habitually reserved for favorable cases, while the other is indiscriminately applied to all the remainder: greatly as I admire the operation of excision, I cannot but believe that, *cæteris paribus*, it is, in every region of the body, at least as fatal as the corresponding amputation.

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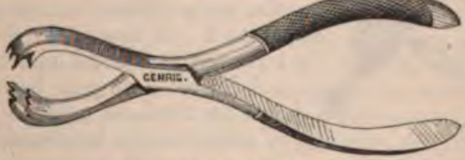
[1] Ollier recommends in such cases an excision of the epiphyseal cartilage of the sound limb, so as to induce such shortening as will correspond with that of the other. The use of a high-soled shoe would seem to me less dangerous.

Process of Repair after Excision.—The growth of the *long bones* in *thickness* is accomplished by means of the periosteum, and in *length* by means of the epiphyseal cartilages. Hence, in excising portions of the shafts of bones, it is of the utmost importance to preserve the periosteum, by the osteo-genetic power of which it may be hoped that the excised portion will be reproduced: another advantage of *subperiosteal* excision is that, by preserving the membrane in question, the attachments of the various muscles are not disturbed. If the periosteum cannot be preserved—and this can rarely be done in excisions of the *short bones*, as of the calcaneum—repair is effected by the wound filling with granulations, which are subsequently transformed into a dense, fibrous, cicatricial mass. In excisions of the *joints* (particularly among patients who have not attained their full height), it is important not to remove the entire epiphysis, nor even to encroach upon the epiphyseal line; for, if this be done, the subsequent growth of the limb will be deficient. This is especially important in the case of the *knee*, the lower epiphysis of the femur and the upper of the tibia being chiefly concerned in the growth of the lower extremity. When this precaution is observed, the shortening is comparatively slight, and, indeed, temporary *elongation* may occur, as in cases of osteitis and arthritis (see pp. 579, 600). An attempt should, as a rule, be made to preserve the periosteum in articular resections, particularly when, as in the case of the shoulder, elbow, or hip, a movable joint is desired—the effect of retaining the periosteum in these cases being, as shown by Ollier, to improve the shape of the new articulating surfaces, which measurably approach the form of those which were removed; in the knee, where the great object is to obtain firm bony union, the subperiosteal character of the operation is not so essential, though still desirable, as tending to diminish the amount of consecutive shortening.

Operation of Excision in General.—The knives ordinarily required for the operation of excision, are scalpels and straight bistouries, which should be pretty thick at the back, and set in strong handles; a strong probe-pointed knife, with a limited cutting edge, will also be found useful for clearing the soft parts from the bones in the deeper portions of the wound. Bone forceps of various sizes and shapes will be required, the most important being strong cutting pliers, and the lion-jawed forceps designed by Fergusson (Fig. 302). Gouges and gouge-forceps will also be found useful for dealing with carious bone. The saw which I prefer, in most cases, is that designed by Butcher, of Dublin (Fig. 303), which has the great merit of allowing the blade to be fixed at any angle, or even completely reversed, so as to cut from below upwards, and thus preserve the soft parts from injury. In certain cases (as in excisions of the hip), the chain saw is more convenient than any other instrument. The chain may be slipped over the part to be removed, or may be applied by the aid of a strong curved needle, or an ingen-

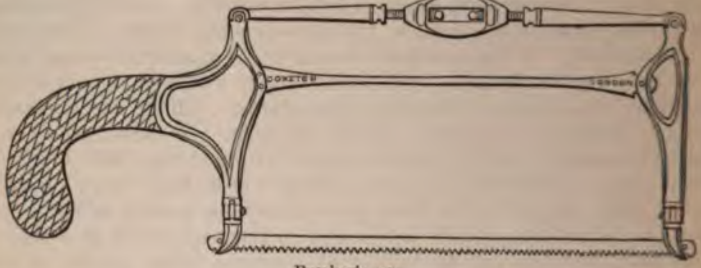
FIG. 302.



Fergusson's lion-jawed forceps.

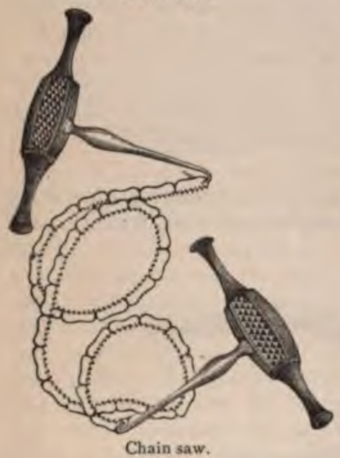
ious conductor devised for the purpose by Dr. Buck, of New York. If an ordinary saw be employed, a spatula or retractor must be slipped beneath the bone, in order to guard the soft parts; a good instrument for the purpose is the "resection sound" of Blandin, or the probe-pointed grooved retractor described by Dr. D. Prince, of Jacksonville, Illinois; or, which in some cases will prove satisfactory, an ordinary broad lithotomy staff grooved on the back, which may be readily slipped around the bone, and then turned with its convexity upwards. Another instrument which I have found of value, is the knife-bladed forceps of Mr. Butcher (Fig. 305). This cuts like a pair of scissors, and is very efficient in removing the thickened and degenerated synovial tissues, which, if allowed to remain, are apt to slough and impede the progress of cure.

FIG. 303.



Butcher's saw.

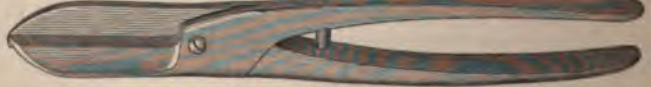
FIG. 304.



Chain saw.

The particular operative procedures required for excision in various regions of the body differ of course according to the parts to be removed; it may be stated, however, in general terms, that the external incisions should be sufficiently free, and as much as possible in the direction of the muscular interspaces, so as to avoid unnecessary destruction of tissue. The incisions should, if practicable, include any sinuses that may be present, and should be made so as to avoid injury to the principal vessels and nerves. The periosteum should be preserved, if possible, and the amount of bone removed should be as small as may be consistent with the thorough extirpation of the diseased structure. It is a good plan in excising joints to remove but a thin layer with the saw, and then to attack any necrosed or carious spots with the gouge or trephine. The epiphyseal line should never be

FIG. 305.



Butcher's knife-bladed forceps for excisions.

encroached upon in children, and, even in adults, it is important not to lay open the medullary canal. Care must be taken not to mistake bone which is merely inflamed and softened (*medullized*), for that which is carious, nor bone thickened and roughened by inflammation, for that which is necrosed. The skin and other soft tissues, no matter how much altered in appearance, should be as a rule preserved entire—the flaps, though at first redundant, ultimately shrinking and resuming their natural condition. The degenerated synovial lining of the joint may, however, be advantageously cut away with the knife-bladed forceps; and, indeed, Volkmann goes so far as to advise complete "extirpation" of the joint capsule. All bleeding should be checked, by ligature or otherwise, before the wound is closed, as it is very important that, when the limb is once adjusted, it should not be disturbed for several days. The dressings should be light and simple, and precautions must be adopted to secure free drainage, by the arrangement of the incisions, or by the use of Chassaignac's tubes, etc. Concentrated food, with tonics and stimulants, will usually be required in pretty large quantities during convalescence.

Finally, although the case should not progress as favorably as may be wished, the surgeon must not hastily conclude that the operation has failed, and that amputation is necessary; even if caries or necrosis should recur in the sawn bony extremities, a *re-excision* may often be attended with a satisfactory result.

SPECIAL EXCISIONS.

Scapula.—Excision of the scapula, complete or partial, may be required for various causes, as caries, necrosis, tumors, and some forms of injury, though in traumatic cases it is often necessary to remove the whole upper extremity as well (see page 119). The operation may be done with a crucial incision, or, which is probably better in most cases, a T-shaped incision, as recommended by Syme, the transverse branch of the cut running from the acromion to the posterior edge of the bone, and the other passing downwards, at a right angle from the centre of the former. If the operation be for *tumor*, the incisions should be merely skin-deep, the flaps being dissected off without cutting into the growth, which may, probably, be very vascular. It is advised by Fergusson and Pollock to liberate the posterior border of the scapula first, and then the inferior, turning up the bone from below upwards as the operation proceeds. By this plan the subscapular artery can be controlled by the finger before division, and the risk of hemorrhage is thus considerably lessened. The subclavian artery should be compressed by an assistant throughout the whole procedure. In cases of *malignant disease*, the whole scapula should be excised, but under other circumstances a partial operation may suffice, there being certainly an advantage in retaining the head of the bone, acromion, and coracoid, when there is no reason for their removal. The clavicle should not be interfered with unless it be itself diseased. After the operation, the arm should be supported in a sling, and an axillary pad may be sometimes advantageously employed for a few days.

The history and statistics of this operation have been particularly investigated by Dr. Stephen Rogers, of New York, and by Dr. Adelmann, of Berlin, who has, however, made no distinction between excisions of the scapula with or without amputation of the arm. Removal of the scapula *with the arm* has been considered under the head of amputation above the shoulder (page 119). The first case in which the entire scapula was removed, *the arm being preserved*, was that of Langenbeck, who, in 1855, excised the whole scapula with three inches of the clavicle. Since then, complete excision of the scapula, with or without interference with the clavicle and head of the humerus (the arm being preserved), appears to have been done in 42 cases, of which 33 terminated successfully, and 7 in death, the result of 2 not having been ascertained.

Cases of Total Excision of the Scapula, the Arm being Preserved.

No.	Operator.	Result.	No.	Operator.	Result.
1	Bellamy,	Undeterm'd.	22	Michaux,	Recovered.
2	Billroth,	Recovered.	23	Michel,	"
3	Id.	"	24	Nixon,	"
4	Bird,	"	25	O'Grady,	"
5	Brigham,	"	26	Id.	"
6	Busch,	"	27	Omboni,	"
7	Choppin,	Died.	28	Orlawski,	"
8	Crawford,	Recovered.	29	Peters,	"
9	Esmarch,	"	30	Pirrie,	"
10	Hamilton,	"	31	Pollock,	Died.
11	Hammer,	"	32	Rogers,	Recovered.
12	Heath,	Died.	33	Schneider,	"
13	Heyfelder,	"	34	Schuh,	"
14	Jones,	Recovered.	35	Schuppert,	"
15	King,	"	36	Spence,	"
16	Kottman,	"	37	Id.	"
17	Langenbeck,	Died.	38.	Steele,	Died.
18	Linhart,	Recovered.	39	Syme,	"
19	Logan,	"	40	Id.	Recovered.
20	MacCormac,	"	41	Wood,	Undetermin'd.
21	Mazzoni,	"	42	——	Recovered.

Extirpation of the scapula, *subsequent to amputation at the shoulder*, appears to have been practised in 13 cases, with 9 recoveries and 2 deaths, the termination of two being unknown.

Cases of Total Excision of the Scapula, subsequent to Amputation at the Shoulder.

No.	Operator.	Result.	No.	Operator.	Result.
1	Buck,	Recovered.	8	Langenbeck,	Recovered.
2	Busch,	"	9	Mussey,	"
3	D'Ambrosio,	Undeterm'd.	10	Rigaud,	"
4	Deroubaix,	Recovered.	11	Id.	"
5	Fergusson,	"	12	Soupart,	Died.
6	Jeaffreson,	"	13	Stimson,	Undetermin'd.
7	Krakowizer,	Died.			

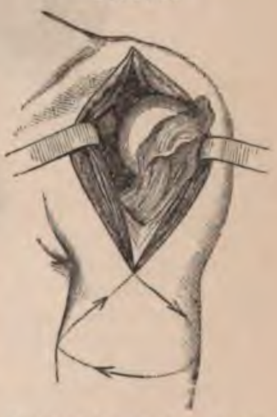
Total is thus more successful than partial excision, 204 cases of which operation, to which I have references, having given 49 deaths, or nearly one in four.

Clavicle and Ribs.—The *clavicle* may require partial or, in rare instances, complete excision, on account of caries, necrosis, tumor, or compound fracture. The inner extremity of the bone may also require resection, if it be so displaced as to produce dangerous compression of the œsophagus or trachea. In cases of necrosis, the operation may be made subperiosteal, and presents no particular difficulties, a simple incision following the course of the bone being sufficient for the purpose. In cases of tumor, the operation is both difficult and dangerous, the principal risks being from hemorrhage and the entrance of air into the veins. Complete extirpation of the clavicle was first practised by McCreary, of Kentucky, in 1811,[1] and has since been occasionally repeated. Prof. Agnew has tabulated 34 cases of this operation, of which number, however, 5 (Mott's, Roux's, Travers's, Cooper's, and one of Wutzer's) appear not to have been complete excisions; of the remaining 29, at least 21 ended in recovery, and 7 in death, the result in one case being undetermined; the mortality is thus about 25 per cent.

Portions of the *ribs* have been frequently excised in cases of caries, necrosis, compound fracture, wound of an intercostal artery, etc. The operation is not particularly difficult, but, except in case of necrosis, when the periosteum can be detached, is attended with considerable risk of injury to the pleura or even the peritoneum. Thirty-seven cases mentioned by Heyfelder gave eight deaths. Resections of the ribs for tumor have been performed by Langenbeck, Warren, McClellan, Kolaczek, Fischer, and other surgeons. Excision of one or more ribs may likewise be employed in cases of empyema. (See p. 372.)

Shoulder-joint.—Excision of the scapulo-humeral articulation, or of the head of the humerus, may be required in cases of arthritis, caries or necrosis, compound fracture or dislocation, or non-malignant tumor. For *malignant* disease the operation would, I think, be improper, as unnecessarily exposing the patient to a recurrence of the affection. The operation may be conveniently performed by making a single longitudinal incision, beginning somewhat to the outside of the coracoid process, and carried downwards and slightly outwards—passing between the fibres of the deltoid muscle, in the line of the bicipital groove for about five inches. The long head of the biceps being held to one side, the capsule is divided, and the tuberosities of the humerus freed by the use of the probe-pointed knife, when the head of the bone may be thrust through the wound and removed with a chain saw, or, in young children, with strong cutting forceps. If the glenoid cavity be diseased, it may then be attacked with the gouge-forceps, or may, if necessary, be exposed for the application of the saw by a transverse cut, as directed for excision of the scapula. Hemorrhage having been arrested, the wound may be closed with a few points of suture, a space being left for drainage (and perhaps a tube introduced), and the arm then supported with a sling and axillary pad. In some cases, as of tumor, the longitudinal incision may not suffice to give access to the part, and the surgeon may then raise a flap by means of a V-shaped cut, or one in the form of a ┐, T, or U, as may be thought most convenient. These all have the common disadvantage of involving a transverse division

FIG. 306.



Excision of shoulder-joint; longitudinal incision. (ERICHSEN.)

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[1] Remmer's operation, in 1732, was only a partial excision.

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of the fibres of the deltoid, and of therefore protracting the healing process, as well as of entailing subsequent weakness of the limb.

The first formal excision of the head of the humerus *for disease* appears to have been performed by Bent, of New Castle (England), in 1771, while the first complete excision of the shoulder-joint was performed by the elder Moreau, in 1786. Shaeffenberg's and Thomas's operations (1726, 1740) are, according to Gurlt, not to be regarded as true excisions. The operation is quite a successful one, considering its magnitude, 169 cases of excision for all causes having given, according to Heyfelder, but 30 deaths, a mortality of less than 18 per cent. If excisions for disease alone be considered, the statistics show an almost equally favorable result, 115 cases tabulated by Culbertson giving 94 recoveries and but 21 deaths. The preserved arm is known to have been useful in more than three-fourths of the successful cases. The risk which attends this procedure, therefore, is so moderate as to render shoulder-joint excision one of the most satisfactory of surgical operations.

Humerus.—Excision of the shaft of the humerus may be occasionally required in cases of compound fracture, especially as the result of gunshot injury (see page 169), or may sometimes be necessary in cases of caries or necrosis. Resection is also not unfrequently called for in the treatment of ununited fracture, and when performed with the precautions recommended by Ollier, of Lyons, and by Bigelow, of Boston, is quite a successful procedure (see page 241). The operation consists in making a single longitudinal incision on the outer side of the arm, between the muscular interspaces, and, after carefully dividing and stripping off the periosteum (which

FIG. 307.

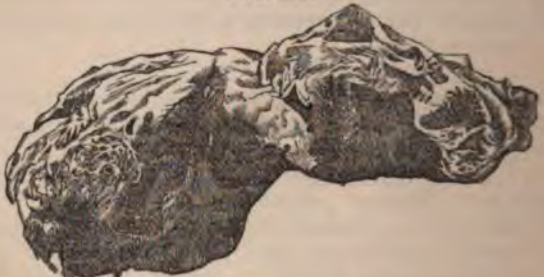
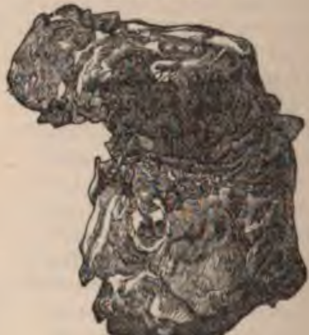


FIG. 308.

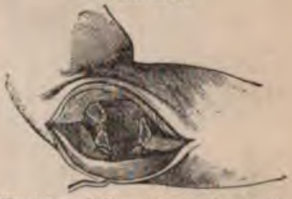


Excised extremities of humerus and ulna. (From a specimen in the museum of the Episcopal Hospital.)

should always be preserved), removing as great an extent of bone as may be thought necessary with a chain saw; the resected bony extremities should then be approximated and held together by means of a strong metallic suture, and the limb placed at rest on a suitable splint. Macewen, of Glasgow, has reported a case in which reproduction of a humerus was effected by transplanting grafts of bone taken from other patients.

Elbow-joint.—Excision of this articulation may be required for chronic disease of the joint, for bony anchylosis, or for compound fracture or luxation. The lower end of the humerus was resected by Wainman (in 1758 or 1759) and by Tyre, while the olecranon and upper part of the ulna were removed by Justamond, in 1775, but the first complete excision of the elbow-joint was performed by the elder Moreau, in 1794, in a case of chronic disease of the articulation. The operation may be conveniently done (as originally suggested by Park) by means of a single longitudinal incision, beginning two inches above the olecranon and carried about three inches below it, the line of the incision being parallel to the course of the ulnar nerve, and a few lines to its radial side. The only point requiring special attention in this procedure is to avoid injuring the ulnar nerve, which must be carefully dissected from its position behind the inner condyle (the edge of the knife being kept close to the bone), and then held out of the way with a blunt hook or spatula. The back of the articulation being thus exposed, the olecranon should be cleared, and may then be cut off with strong cutting pliers, this, though not essential, serving greatly to facilitate the subsequent steps of the operation.[1] In order to preserve the function of the triceps muscle, Spence divides its tendon by an inverted Λ-shaped incision, while Hodges and Maunder take care not to cut the tendinous fibres which are inserted into the fascia of the forearm. With the same object, Prof. Sayre leaves that portion of the olecranon to which the tendon is attached. The joint being forcibly flexed, and the forearm thrust backwards, the lateral ligaments may now be carefully divided with the probe-pointed knife. The operation is completed by removing the condyles and the articulating surfaces of the radius and ulna, with Butcher's saw. The tubercle of the radius should, if healthy, be left undisturbed, so as to preserve the attachment of the biceps tendon. Bigelow also preserves the external and internal condyles of the humerus. Some surgeons employ a transverse incision in addition to that which has been described, making a wound of this form ⊢, while others (as Mr. Butcher, and the late Mr. Syme) add also a second longitudinal incision on the outside of the joint—H, thus forming two rectangular flaps. The simple longitudinal incision is, however, perfectly satisfactory in the majority of cases, and is better adapted for rapid healing than either of the others, having no tendency to gape. As soon as the bleeding has been checked, the wound should be lightly dressed, and the limb laid upon a pillow, or well-padded splint, in a nearly straight position; after a week or two, when consolidation has begun, the splint may be discarded, and the limb simply supported in a sling.

FIG. 309.



Excision of elbow-joint by longitudinal incision. (BRYANT.)

The results of elbow-joint excision, when performed for chronic joint-disease, are commonly very satisfactory, 377 cases tabulated by Culbertson having given but 41 deaths, a mortality of only 10.8 per cent. Ollier reports 36 cases performed by the subperiosteal method, of which only 5 proved fatal. With regard to the condition of the limb after excision, the statistical results are equally satisfactory: thus according to Hodges, 77 out of 89 patients who recovered had useful arms, while in 94 out of 118 successful cases tabulated by Heyfelder and Boeckel, the patients could make good use of their preserved limbs. *Partial* excision of the elbow-joint appears to be a less successful operation than *total* excision, which should therefore be preferred, even though all the articular extremities be not diseased. Twenty-one cases of partial excision embraced in Hodges's tables, gave five deaths, three subsequent amputations, and only nine recoveries with a useful limb.

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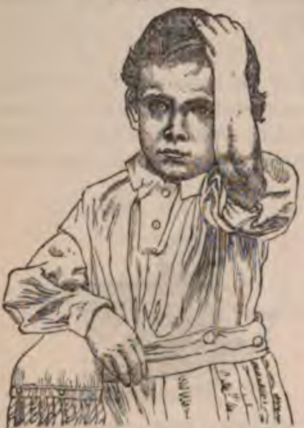
[1] Trendelenberg and Völker recommend *temporary resection* of the olecranon, which they subsequently restore to its position.

FIG. 310.



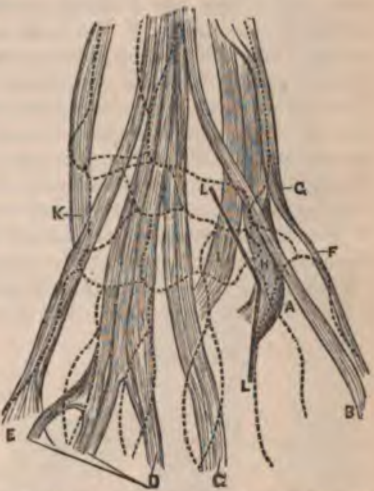
Result of excision of elbow-joint. (From a patient in the Children's Hospital.)

Radius and Ulna.—Dr. Compton, of New Orleans, in 1853, excised the whole ulna and greater part of the radius, while the whole radius has been excised by Carnochan, of New York, and the whole ulna by the same surgeon, by Jones, of Jersey, by Joseph Bell, of Edinburgh, and by Hutchinson, of Brooklyn, New York. Erichsen in one case excised the elbow-joint, together with the greater portion of the radius, while Williamson made a still more extensive resection, embracing the elbow-joint and the entire ulna. The result in all of these cases appears to have been satisfactory, the patients recovering with useful limbs. *Partial* excisions of one or both bones have been frequently performed and usually with very good results. The operation consists in making a longitudinal incision on the back of the forearm, in the line of the bone to be resected, the periosteum being if possible preserved, and the bone divided with chain saw or cutting pliers.

Wrist.—The lower extremity of the radius was excised by Cooper, of Bungay, in 1758, but complete excision of the wrist-joint seems to have been first performed by the elder Moreau, in 1794. The articulation may be excised by means of one or two longitudinal incisions on the dorsum of the wrist, the carpal bones being removed piecemeal, or by *Lister's operation*, which is thus performed: A *radial* incision begins about the middle of the dorsal aspect of the radius, on a level with the styloid process, and passes downwards and outwards towards the inner side of the metacarpo-phalangeal articulation of the thumb, but, on reaching the line of the radial border of the metacarpal bone of the index finger, diverges at an obtuse angle (Fig. 311), and passes downwards longitudinally for half the length of that bone; an *ulnar* incision begins two inches above the end of the ulna and immediately in front of that bone, passes downwards between the flexor carpi ulnaris and the ulna, and terminates at the middle of the palmar aspect of the fifth metacarpal. The only tendons necessarily divided by this method are the extensors of the wrist. The trapezium is to be separated from the rest of the carpus by cutting with the bone forceps before the ulnar incision is made, but is not to be removed till a later stage of the operation; similarly, the pisiform bone is to be separated and left attached to the flexor carpi ulnaris, while the hook of the unciform bone is also severed and left attached to the annular ligament. The tendons being then raised both before and behind the wrist, the anterior ligaments of the joint may be divided, and the cutting pliers introduced first between the carpus and radius, and afterwards between the carpus and metacarpus. Its connections being thus divided, the whole carpus (except the trapezium and pisiform) may be pulled out with a pair of strong forceps. The articulating extremities of the radius and ulna can now be made to protrude through the ulnar incision and can be retrenched as much as may be thought desirable, the ulna being sawn obliquely so as to retain its styloid process and thus lessen the tendency to subsequent displacement. The articulating ends of the metacarpal bones are then protruded and excised, and the operation completed by dissecting out the trapezium,[1] and by removing the articulating surface of the thumb, and as much of the pisiform and hook-like process of the unciform as may be found necessary. A portion of the ulnar wound is left unclosed for drainage, and the hand is kept during the after-treatment upon a splint fitted with cork supports for the palm and thumb, or, which would answer as well, an ordinary Bond's splint with the side pieces removed.

The statistics of wrist-joint excision for disease are quite favorable, 85 terminated cases, tabulated by Culbertson, giving but 10 deaths, and as many subsequent amputations.

FIG. 311.



A. Radial artery. B. Tendon of extensor secundi internodii pollicis. C. Indicator. D. Extensor communis digitorum. E. Extensor minimi digiti. F. Extensor primi internodii pollicis. G. Extensor ossis metacarpi pollicis. H. Extensor carpi radialis longior. I. Extensor carpi radialis brevior. K. Extensor carpi ulnaris. L L. Line of radial incision. (LISTER.)

Hand.—The *metacarpal bones* or *metacarpo-phalangeal joints* may be excised by simple longitudinal incisions on the back of the hand, the extensor tendons being held to one side, and the bone sections made with strong cutting pliers. A similar procedure is required for excision of the *inter-phalangeal joints*, except that in this case the articulation should be approached from the side.

Hip.—Excision of the hip-joint may be required in cases of *injury* (especially from gunshot wound), of *hip disease*, and possibly of *necrosis*, though, in cases of the latter affection, it would usually be proper to wait for the spontaneous separation of the femoral epiphysis, which could then be extracted with comparatively little risk. Hip-joint excision has likewise been performed for *malignant disease*, for *anchylosis*, and for *rheumatoid arthritis*, but is not, in my opinion, a suitable operation in any of those conditions. J. W. Howe has recorded a case of successful excision of the hip for ununited fracture. Excision of the hip-joint was suggested by Charles White, of Manchester, in 1769, but was first practised by Anthony White, of London, in 1822. The first operation in this country appears to have been performed by Bigelow, of Boston, in 1852. A simple longitudinal incision on the outside of the limb will usually give ready access to the joint, but may be supplemented, if necessary, by a transverse cut forming a ⊢. The incision which I myself prefer, is that recommended by O. Heyfelder, which begins a little above and behind the great trochanter, towards which it passes in the line of the fibres of the gluteus maximus, and then, curving around and behind the trochanter, passes downwards and slightly backwards, ending on the linea aspera between the insertions of the gluteus and vastus externus (Fig. 312). This incision forms two irregular flaps, the loosening of which affords abundant room for the subsequent steps of the operation, while no muscular fibres are divided transversely. If spontaneous dislocation has occurred, the head of the bone may be at once protruded through the wound, but under other circumstances the capsule must be opened, and the ligamentous structures cautiously divided with the probe-pointed knife. Prof. Sayre lays great stress upon the importance of a subperiosteal excision, but my own experience leads me to agree with Mr. Holmes in thinking that the subperiosteal method presents no particular advantages in this situation. The femur may be divided with the chain saw (or in young children with cutting pliers) immediately below the great trochanter, it being always advisable to remove this portion of bone, even if not diseased, as it is apt to become so subsequently, and to interfere with union by protruding through the wound. The acetabulum should then be carefully examined; if healthy, it may be left untouched, but if carious or necrosed, it should be freely dealt with, loose pieces being extracted, and any part that is diseased, but not loose, removed with the gouge-forceps, trephine, or Hey's saw. It was formerly taught that interference with the acetabulum was unjustifiable, and that extensive disease of the pelvis therefore forbade the hope of successful excision; it is now, however, well established, through the labors of Hancock, Erichsen, and others, that the acetabular form of the disease is almost equally amenable to operative treatment as the femoral, and the entire bony floor of the acetabulum

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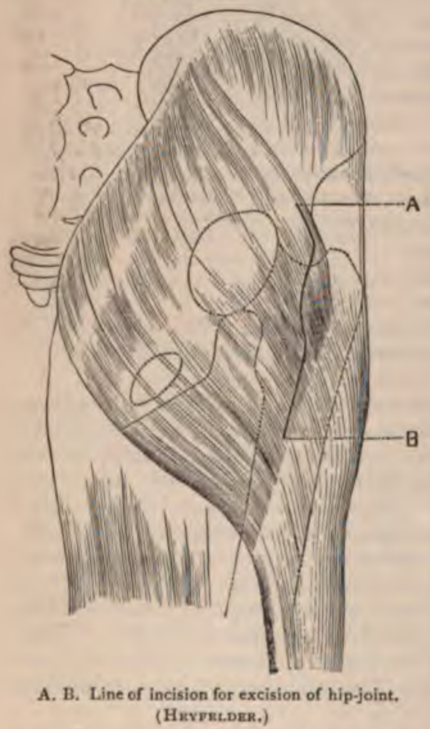
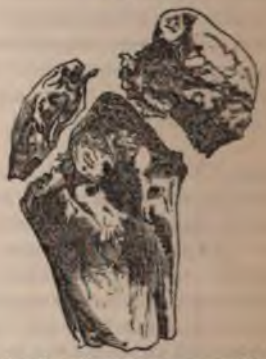
[1] W. R. Williams employs a single incision on the ulnar side of the wrist, and endeavors to preserve the trapezium, believing that the utility of the thumb in great measure depends upon its retention.

FIG. 312.



A. B. Line of incision for excision of hip-joint. (HEYFELDER.)

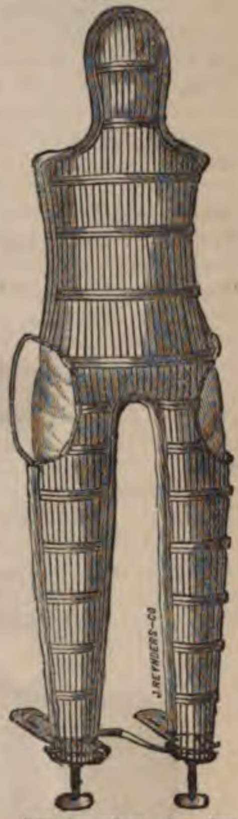
FIG. 313.



Head and neck of femur removed by excision. (From a specimen in the museum of the Episcopal Hospital.)

and even large portions of the ischium and pubis, have, accordingly, been safely removed. There is, as shown by Hancock, no risk of opening the cavity of the pelvis in these operations, for its inner wall, composed of fasciæ and muscles which are thickened and infiltrated with lymph, forms an effectual barrier to prevent the possibility of such an occurrence.

FIG. 314.



Sayre's cuirass for after-treatment of hip-joint excision. (SAYRE.)

. The after-treatment of hip-joint excision is very simple: free drainage must be secured for the wound, which should be lightly dressed—the patient being kept in bed, with the limb well abducted, so as to prevent any tendency to projection of the sawn extremity of the femur. Moderate extension may be made by means of a weight, while the limb is kept in place by the apposition of sand-bags. As soon as the wound is sufficiently consolidated, the patient should be allowed to get about with crutches, or with a well-fitting Davis's or Sayre's splint, or with that devised by Andrews, of Chicago, which acts by supporting the perineum upon a crutch-piece extending down the limb and riveted to the heel of the shoe. Prof. Sayre places the patient immediately after the operation in a wire "cuirass," padded to prevent excoriation, and provided with screws to make extension (Fig. 314). *Re-excision* has been occasionally practised with advantage, while *amputation*, subsequent to excision, has resulted favorably in at least twenty out of thirty-four cases in which it has been done.

Elaborate statistics of hip-joint excision have been published by several authors, myself included, but the largest number of cases yet tabulated is embraced in Dr. Culbertson's Prize Essay, published in 1876. I have myself performed the operation in seventeen cases with five deaths.

The following tables, compiled from Culbertson's, exhibit, in a form easy for reference, the statistics of the operation, as performed at different periods of life, and the comparative results, according as the acetabulum was or was not interfered with, or, in other words, of *complete* as compared with *partial excision.*

Results of Hip-joint Excision at Different Ages.

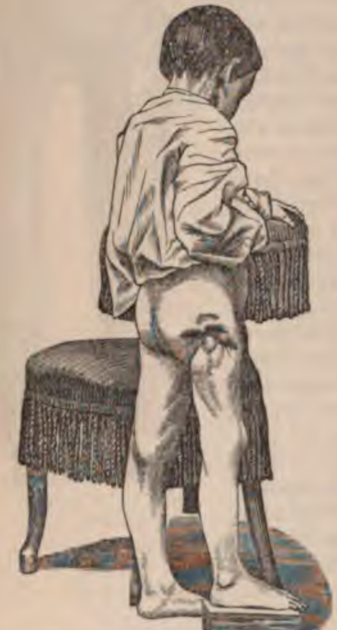
AGE.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Under 5 years	51	29	18	4	38.3
Between 5 and 10 years	162	102	48	12	32.0
" 10 " 15 "	85	40	35	10	46.7
" 15 " 20 "	52	22	26	4	54.2
" 20 " 30 "	39	11	22	6	66.7
Over 30 years	26	9	14	3	60 9
Age not stated	55	21	29	5	58.0
Aggregate	470	234	192	44	45.1

Comparative Results of Complete and Partial Excision.

FORM OF EXCISION.	Total.	Recovered.	Died.	Result undetermined.	Mortality per cent. of terminated cases.
Complete excision	177	90	77	10	46.1
Partial "	241	124	97	20	43.9
Form not stated	52	20	18	14	47.4
Aggregate	470	234	192	44	45.1

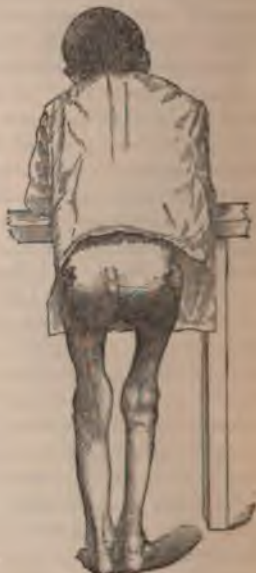
With regard to the *utility of the limb* after excision of the hip-joint, it may be said in general terms that a favorable result will be secured in two-thirds of the instances of recovery, the limb being reported as useful in 166 out of the above 234 successful cases. From the first of the preceding tables, it is seen that the most favorable age for the operation is from five to ten years, the mortality increasing after puberty, and in adult life being so large as to be almost prohibitory. Even at the most favorable period, the death-rate is almost one in three, the operation being thus nearly as often followed by death as ligation of the third part of the subclavian or of the external iliac, and more often than amputation at the shoulder for all ages. The second table shows that *complete* is, upon the whole, very nearly as successful as *partial* excision, and that hence the acetabulum should be freely gouged in any case in which it is found to be diseased.

FIG. 315.



Result of hip-joint excision. (From a patient in the Episcopal Hospital.)

FIG. 316.



Excision of both hip-joints. (From a patient in the Children's Hospital.)

The results of hip-joint excision, it will therefore be seen, are not very brilliant—one out of three dying under the most favorable circumstances, and but two out of seven recovering with useful limbs. Ought we, then, to abandon the operation? I answer, certainly not. The question is not so much, what does excision promise? as, does any other mode of treatment promise as well? What, in fact, can the opponents of hip-joint excision offer instead? The operation is indeed such a grave one that I have seldom felt that it was justifiable to resort to it in any case in which it was not evident that life would be endangered by persistence in expectant measures. But in cases of hip disease in which suppuration has occurred, there usually, sooner or later, comes a time when the only alternatives are excision, amputation, or a prolonged and painful illness, terminated by death. These patients very rarely (at least in the class of cases which we see in hospital practice) recover under expectant treatment; they are carried from one hospital to another, and at last die worn out by suppuration or visceral disease, or are carried off from a life of pain and weariness by some intercurrent affection.[1] No one, probably, at the present day, would think of *amputating* in any case of hip disease to which excision was at all applicable; and, indeed, apart from the mutilation necessarily entailed, the mortality after the operation is not inconsiderable—at least 9 out of 34 cases amputated for hip disease having terminated fatally; so that *excision* is, in a good many instances, the surgeon's only available resource, and, as such, should be employed without hesitation. In this respect, excision of the hip-joint differs from that of any other articulation of the body, and, as justly remarked by Mr. Holmes, "in cases which show a decided tendency to get worse, we may pretty confidently reckon all the recoveries after the operation as a clear gain." I once had occasion to resort to excision of both hip-joints in the same patient. The result (Fig. 316) as regards life was satisfactory, but the patient was not able to walk without crutches as long as he remained under my observation. A similar operation has since been performed by Mr. Croft.

Cases of Primary Amputation at the Hip-joint for Hip Disease.

No.	Operator.	Result.	No.	Operator.	Result.
1	Alexander,	Recovered.	18	Lee,	Recovered.
2	Allen,	"	19	Mack,	"
3	Baffos,	Died.	20	Macnamara,	"
4	Boeckel,	Recovered.	21	Maisonneuve,	"
5	Cowell,	"	22	Marshall,	"
6	Cumming,	"	23	Mason,	"
7	Curling,	Died.	24	Richardson,	"
8	Id.	Recovered.	25	Rivington,	"
9	Davy,	"	26	Id.	Died.
10	Duffee,	"	27	Secourgeon,	"
11	Foulis,	"	28	Stokes,	Recovered.
12	Hughes,	Undeterm'd.	29	Stout,	"
13	Hutchinson,	Recovered.	30	Tay,	"
14	Id.	"	31	Thompson,	Died.
15	Id.	Died.	32	Wheatcroft,	"
16	Id.	"	33	Young,	Recovered.
17	Kerr,	"			

Knee-joint.—Excision of the knee-joint may be required in cases of chronic disease of that articulation, and may be occasionally justifiable in cases of compound fracture or dislocation, or of angular anchylosis. This operation appears to have been first performed by Filkin, of Norwich, in 1762 (the case terminating in recovery), and was again successfully done by Park, in 1781. So little favor, however, did the procedure meet with in the eyes of surgeons generally, that forty years ago it had been performed less than twenty times. Revived by Textor, in Germany, and by Fergusson, in England (the last-named surgeon operating for the first time in 1850), it has since been resorted to so frequently that its statistics are now more extensive than those of any other excision.

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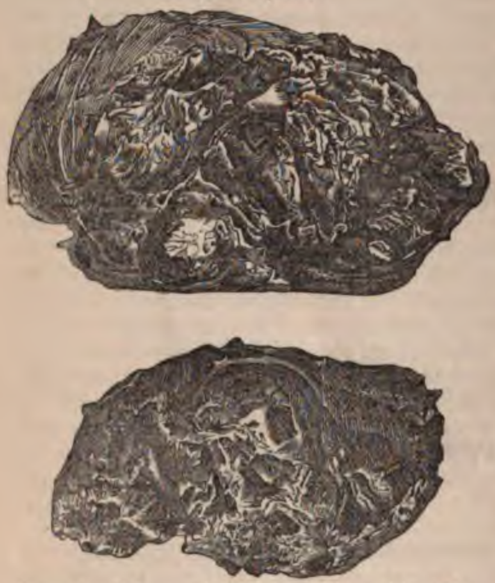
[1] Twelve cases noted by Gibert at the Hospital "Sainte-Eugénie," gave one recovery, three "not cured," and eight deaths.

Figs. 317, 318.



Extremities of femur and tibia removed by excision of knee-joint. (From a specimen in the museum of the Episcopal Hospital.)

The operation may be performed in several ways,[1] the methods most deserving attention being by the **H**, the **U**, and the simple transverse incision. The **H** incision was first employed by Moreau, and consists of two longitudinal incisions, one on either side of the joint, with a transverse cut passing immediately below the patella. The lateral incisions should be placed far back, so as to give ready access to the femoral condyles, and to insure free drainage subsequently. This method, which is preferred by Butcher, greatly facilitates the subsequent steps of the operation, but has the disadvantage of making an unnecessarily large wound.

The **U**, *horseshoe*, or *semilunar, incision* was first practised by Mackenzie, and is still preferred by many surgeons. This method consists in raising an anterior flap containing the patella, the base of the flap reaching to above the condyles. The ligamentum patellæ is divided in the first incision, when, the crucial and lateral ligaments being cut, the articulating extremity of the femur can be readily excised with a Butcher's saw. The limb being then flexed and forcibly thrust upwards, the extremity of the tibia can be made to protrude, and may be removed with the same instrument.

The best, in my judgment, is the *simple transverse incision* across the front of the joint, which was suggested by Park, but which appears to have been first employed by Textor, Kempe, of Exeter, and Fergusson. It makes a smaller wound than either of the other methods, and has proved quite satisfactory in twenty-three cases in which I have employed it. It is to be observed, however, that an incision which is transverse to the axis of the tibia, when the limb is flexed to a right angle (as it frequently is in these cases), will, when the excision is completed and the limb extended, form an obliquely curved wound, with its convexity downwards, so that this is in many cases really a flap-operation. The incision should reach on either side to the posterior edge of the base of the condyles (so as to secure drainage), and should at its centre come far enough forward to pass below the patella. The joint having been laid open, the skin and fascia are dissected up as far as may be necessary, and an incision then made directly down to the bone in the line of proposed section; the lateral and crucial ligaments (if these remain) having been next divided, the blade of Butcher's saw is slipped beneath the bone, which is cut through from below upwards.

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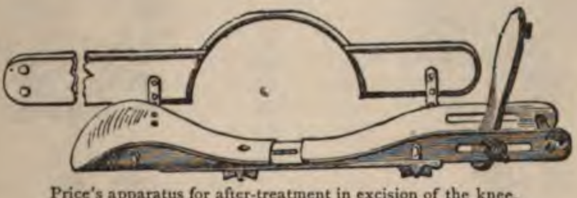
[1] Treves, of Margate, reviving the plan of Jeffray and Sédillot, recommends lateral incisions without any transverse wound.

In sawing through the articulating extremity of the femur, the natural obliquity of this bone should be borne in mind, and the section made in a line parallel to that of the free surface of the condyles; if this be neglected, and the section made transverse to the axis of the femur, the limb after adjustment will be found to be markedly bowed outwards. It should also be remembered that the situation of the epiphyseal line is somewhat higher on the anterior than on the posterior surface of the thigh-bone—so that it may be given as a safe rule, that the section of the condyles should be in a *plane which, as regards the axis of the femur, is oblique from behind forwards, from below upwards, and from within outwards.* The section of the tibia should be in a plane transverse to the long axis of the bone, with a slight antero-posterior obliquity so as to correspond with that of the section of the condyles. The epiphyseal cartilage of the tibia is less important for growth than that of the femur, and need not therefore be so scrupulously respected. The *patella* should be removed, whether it be or be not diseased; it is shown by Péniére's researches that, while its excision diminishes the risk of death by nearly one-third, its retention more than doubles the probability of subsequent amputation becoming necessary. The bone sections being made, and the patella removed, the operation is completed by clipping away with scissors curved on the flat, or with Butcher's knife-bladed forceps, all the fungous and degenerated synovial lining of the joint, taking care, however not to sacrifice the posterior ligament, which serves a useful purpose in preventing displacement, and in protecting the important structures in the popliteal space.

The limb should be dressed while the patient is yet in a state of anæsthesia: for this purpose, the leg is brought into the extended position, the bone sections accurately adjusted, and the whole limb securely fixed upon the splint on which it is to be kept. It may occasionally happen that the limb cannot be brought into the straight position by the application of any justifiable amount of force: under such circumstances the hamstring tendons may be carefully divided, this procedure, though in itself undesirable, being preferable to the removal of an additional segment of bone. The chief difficulty to be contended with, during the after-treatment, is to prevent the anterior projection of the cut extremity of the femur, and hence the surgeon may with advantage, particularly in cases of children, fix the bones in apposition by means of a strong metallic suture, as originally employed by Gurdon Buck, of New York, and since resorted to by many other surgeons. In operations upon adults, however, this will not, I think be found necessary,

FIG. 319.

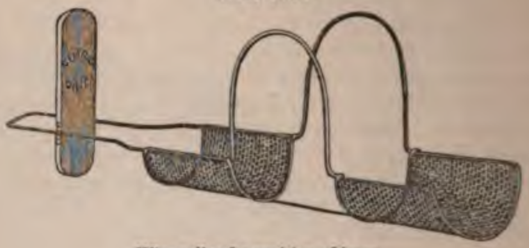


Price's apparatus for after-treatment in excision of the knee.

particularly if the bone sections be made, as above recommended, in a plane slightly oblique from behind forwards and from below upwards—a suggestion which appears to have originated with Billroth, and which is readily carried out with the aid of Butcher's saw.

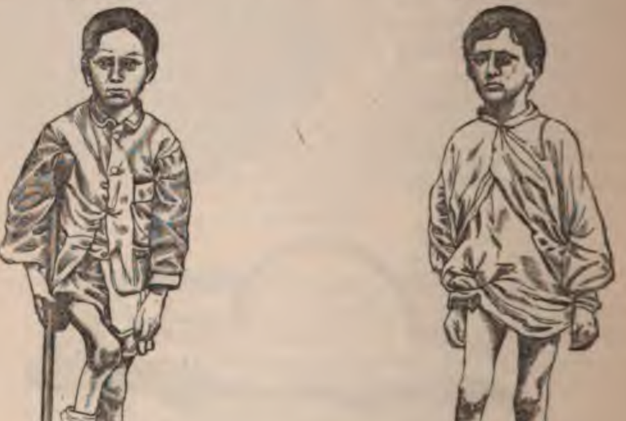
A good splint for the after-treatment of knee-joint excisions is that known as Price's (Fig. 319), and excellent cures have been obtained with Butcher's box splint, or, as recommended by Watson, of Edinburgh, with a posterior moulded splint and an anterior wire rod to enable the limb to be suspended. The essential points to be secured are *absolute immobility of the limb*, and *ready access to the wound;* and I have myself been abundantly satisfied with a simple bracketed wire splint (Fig. 320), with a movable foot-piece, the splint being, of course, well padded, and the thigh, leg, and foot firmly fixed with bandages and broad strips of adhesive plaster. When the splint has been adjusted, the limb should be laid on a pillow, or, still better, in a large and loose fracture box. Any tendency to anterior projection of the femur may be counteracted, as advised by Butcher, by using in addition a short

FIG. 320.



Wire splint for excision of knee.

FIG. 321. FIG. 322.



Excision of knee-joint for recurrent arthritis with partial anchylosis in bad position. (From a patient in the Episcopal Hospital.)

anterior splint, while the risk of outward bowing may be prevented by using an *external* splint, a metal spring and truss-pad, as ingeniously suggested by Swain, or, which I have found sufficient, a simple strip of adhesive plaster carried around the outside of the limb and secured to the inner side of the splint. The object being to obtain firm bony union, the splint should be removed as seldom as possible, and the first application should suffice, if possible, for at least a fortnight; and, indeed, I have occasionally extended this time with advantage to five or six weeks.

The *statistics* of excision of the knee-joint have been investigated by a number of writers, and elaborate tables have been published by Butcher, Heyfelder, Hodges, Péniéres, Picard, and many others. The most recent researches upon this subject are those of Culbertson, who has analyzed nearly 700 operations, of which no less than 603 were for chronic disease of the articulation. These 603 cases gave 419 recoveries and 178 deaths, the result in six not having been ascertained; the total mortality of terminated cases was therefore 29.8 per cent. The following table will exhibit the results more in detail:—

Recovered without further operation	354 or 58.7	per cent.
" with useful limbs	246 or 40.8	"
Result undetermined (one amputated)	6 or 1.0	"
Amputation subsequently (65 recovered, 12 died, and 1 undetermined)	78 or 12.9	"
Died after excision	166 or 27.5	"
Death-rate of terminated cases in which no further operation was performed	31.9	"

It is thus seen that, even when excision fails, consecutive *amputation* is attended with comparatively little risk, less indeed than thigh amputation for disease in general.

The following table, compiled from Culbertson's, shows in a very satisfactory manner the mortality of knee-joint excision at different ages:—

Results of Knee-joint Excision at Different Ages.

AGE.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
1 to 5 years	19	11	7	1	38.9
5 to 10 "	106	88	17	1	16.2
10 to 15 "	99	81	18	...	17.2
15 to 20 "	84	58	25	1	30.1
20 to 25 "	67	40	26	1	39.4
25 to 30 "	55	34	20	1	37.0
30 to 40 "	65	38	27	...	41.5
Over 40 "	19	9	10	...	52.6
Not stated	89	60	28	1	31.8
Aggregate	603	419	178	6	29.8

It thus appears that the operation of knee-joint excision, which is quite fatal in very early childhood, is not attended with much risk from the age of five up to the period of puberty; while from that time the danger steadily increases, till in adult life the operation is again one of a very serious nature. We may, therefore, probably say, with Holmes, that fourteen is, all things being considered, about the most favorable age—there being then comparatively little danger of consecutive shortening, while the operation is at the same time not attended with any particular risk to life. Excision of the knee-joint should not as a rule be performed during the first five years of life, while it must be deemed an extremely grave procedure in persons past the age of thirty. Of 23 operations in my own hands, the result in 2 is still undetermined; 18 of the remainder have ended in recovery with useful limbs; 1 ended in recovery after amputation; and only 2 have terminated fatally.

Bones of the Leg.—Excision of the *tibia* is rarely justifiable, but may occasionally be proper in cases of acute necrosis from subperiosteal abscess (see p. 589). The operation requires a single longitudinal incision, the bone being then divided with a chain saw, and wrenched from its epiphyseal attachments with the lion-jawed forceps. Excision of the *fibula*, which may be required for compound fracture or for necrosis, may be effected by a similar operation, care being taken to prevent subsequent eversion of the foot, by the use of a suitable splint.

Ankle.—Excision of the ankle-joint, first employed by the elder Moreau in 1792, may be required for compound fracture or dislocation, or for disease of the articulation. The operation may be performed by means of two lateral incisions, one behind either malleolus, or, which is probably better, by means of a semilunar incision passing around the lower border of the external malleolus, and continued in a longitudinal direction along the line of the fibula. The anterior portion of the incision should not extend so far as to endanger either the extensor tendons or the dorsal artery of the foot. Having divided the peroneal tendons, the surgeon may remove the lower end of the fibula,[1] when the astragalus will come into view. If this bone be but slightly affected, it will be sufficient to remove its upper articulating surface with saw or cutting forceps, and to gouge away such portions as may seem diseased, but under other circumstances the astragalus should be removed entire. The foot being then inverted, the lower end of the tibia is to be cautiously cleared with the probe-pointed knife, the inner malleolus being cut away with strong forceps, and as much of the articulating extremity of the tibia as may be thought necessary removed with the chain saw; or a second incision may be made on the inner side of the limb, and the extremity of the tibia removed with a narrow saw passed across from one side to the other. The limb may be kept during the after-treatment in a fracture-box, or on a posterior wire splint provided with a foot-piece. The foot must be well supported, lest anchylosis with a "pointed toe" ensue.

The *statistics* of excision of the ankle-joint for disease have been investigated by Spillman, Hancock, Poinsot, and Culbertson, the latter of whom has collected 124 cases. The disease, in most instances, was caries or arthritis, but occasionally necrosis, bony tumor, etc. The results may be seen in the following table:—

NATURE OF OPERATION.	Total.	Recovered.	Died.	Result not determined.	Mortality per cent. of terminated cases.
Partial excision	68	57	4	7	6.6
Complete "	51	45	6	...	11.8
Undetermined	5	5	...	...	...
Aggregate	124	107	10	7	8.5

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[1] Polaillon divides the fibula with a chain saw *above* the external malleolus, which he leaves attached to the astragalus and calcaneum.

The condition of the preserved limb in most of the cases of recovery is said to have been quite satisfactory, Culbertson giving the proportion of useful limbs as 66 per cent., and Stauff, as quoted by Rose, as 75 per cent.

Foot.—The only excisions of *tarsal bones* which require special notice are those of the *astragalus* and of the *calcaneum.*

Excision of the Astragalus may be required in cases of compound fracture or dislocation (or even simple dislocation, if irreducible), caries, necrosis, etc. The operation requires a semilunar incision on the anterior and outer aspect of the joint. The removal of the bone may often be facilitated by cutting across its neck with strong pliers, when the fragments may be successfully dislodged with elevator and forceps, the probe-pointed knife being cautiously used in the deep portions of the wound; but in other cases it may be necessary to remove the bone piecemeal by means of the gouge.

The *statistics* of this operation (which was first performed in 1582 by a surgeon of Duisburg, in a case recorded by Hildanus) have been investigated by Hancock and Poinsot, the former of whom finds that of 112 patients submitted to total excision, 79 recovered with useful limbs, 2 were cured by amputation, and 19 died, while in 12 cases the result was not ascertained. The mortality of terminated cases was thus exactly 19 per cent. The same writer has collected 28 cases of partial excision of the astragalus, with 18 satisfactory recoveries, one cured by amputation, and one death. Poinsot has collected in all 144 cases, of which 26, or 18 per cent., terminated fatally.

Excision of the Os Calcis is occasionally required in cases of caries or necrosis of that bone, though in the majority of instances free gouging, or the extraction of sequestra, will suffice. The operation of excision of the calcaneum may be done by raising a heel flap, as in Syme's amputation, or (as recommended by Erichsen) by turning down an elliptic flap constituted of the tissues of the sole, and then making two lateral triangular flaps, by carrying a longitudinal cut through the tendo Achillis to meet the former incision. A still better method is that of Holmes, in which an incision is made on the level of the upper part of the bone, beginning at the *inner* border of the tendo Achillis (which it divides), and passing around the back and outer surface of the foot as far forward as the mid-point between the heel and the base of the fifth metatarsal bone, a second incision passing at a right angle from near the *anterior* end of the former, downwards to the commencement of the grooved internal surface of the os calcis. The flap thus formed, which includes the cut peronei tendons, is then reflected from the bone, when the ligaments of the calcaneo-cuboid joint being divided, the calcaneum itself can be slightly displaced inwards, so as to facilitate the division of the various ligaments between that bone and the astragalus. This being done, the calcaneum is twisted outwards, and carefully separated from the soft parts on its inner side. The operation is completed by stuffing the cavity with a strip of oiled lint, and by fixing the foot at a right angle with the leg, by means of an anterior moulded splint. Southam, and Lund, of Manchester, employ a single external incision, beginning as in Holmes's operation, but carried forwards to a point midway between the projection of the fifth metatarsal and the tip of the malleolus. From a recent discussion in the Clinical Society of London, it would appear that the result of the operation is most satisfactory when no attempt is made to preserve the periosteum.

The *statistics* of excision of the os calcis, which appears to have been first performed by Monteggia in 1814, have been studied by Burrall,[1] of New

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[1] Bellevue and Charity Hosp. Reports, 1870, p. 91.

York, and by Polaillon[1] and Vincent,[2] of Paris. The last-named writer has collected 79 cases, which resulted as follows: 49 patients recovered with useful limbs, 5 recovered, but without much use of the preserved member, 10 submitted to subsequent amputation, and 5 died, while the result in 10 cases was not ascertained. If we add 6 successful cases reported by McGuire, of Richmond, Va., and Poore, of New York, we shall have a total of 75 terminated cases, giving 55 recoveries with useful limbs, and but 5 deaths, a mortality of less than 7 per cent. Vincent's statistics show that subperiosteal excision is more dangerous than the ordinary operation, having given 3 deaths out of 23 cases.

The other tarsal bones, or those of the metatarsus or toes, comparatively seldom admit of excision, the disease, when too extensive for successful gouging, usually requiring amputation; I have, however, myself, several times had occasion to resort to excision of one or more bones of the tarsus and metatarsus; and P. S. Conner has collected 35 cases, including 2 of his own, in which two or more bones were removed at one operation, 25 of the whole number having terminated in recovery, 5 in failure, and 5 in death. The same surgeon has also reported a case in which he successfully removed the *whole tarsus*, the rest of the foot being preserved. When excision is resorted to, the lines of incision should be regulated by the position of external sinuses; no rules can be given which in such cases would admit of general application. The joint between the astragalus and calcaneum has been successfully excised by Annandale.

CHAPTER XXXIII.

ORTHOPÆDIC SURGERY.

ORTHOPÆDIC[3] surgery is that branch of surgical science which treats of the means of remedying deformities, congenital or acquired. Etymologically, the term should be used only with reference to the deformities of childhood, and might be taken to embrace a great variety of subjects, such as the removal of tumors, the reduction of dislocations, etc. In practice, however, the application of the term is limited to a few particular kinds of deformity, as wry-neck, lateral curvature of the spine, club-hand, or club-foot, and contractions of joints not due to articular disease, while, on the other hand, no reference is intended to the *age* of the patient in whom these deformities occur. Among those who in this country have particularly illustrated this branch of surgery, may be mentioned J. M. Warren, Bigelow, Brown, Detmold, Sayre, Bauer, Prince, Mütter, and J. Pancoast.

WRY-NECK.

This affection, which is also known as *Torticollis*, or *Caput Obstipum*, is occasionally congenital, but more often originates in children from three to ten years old. It consists in a contraction of the cervical muscles, particularly the sterno-cleido-mastoid and trapezius, usually on one side only, but sometimes on both. The head is drawn downwards and inclined to the affected side, being at the same time rotated in the opposite direction. In the congenital form of the disease, and in that which is acquired (if long continued), the deformity is increased by defective development of the corresponding side of the face and head. The cervical vertebræ undergo rotation on their axis, becoming twisted, and serving to maintain the deformity, and ultimately compensatory lateral curvature is developed in the rest of the spinal column.

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[1] Archives Générales de Médecine, Sept. et Oct. 1869.

[2] De l'ablation du calcaneum, etc., Paris, 1876.

[3] From ὀρθος (straight), and παις (child).

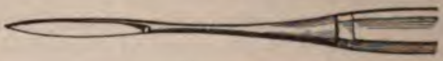
Wry-neck is more common in girls than in boys; it is apparently due to irritation of the spinal accessory nerve—the *non-congenital* variety coming on after the eruptive fevers, or as the result of glandular inflammation or ordinary muscular rheumatism. It sometimes occurs as a reflex phenomenon, depending on the irritation of teething, or of intestinal parasites. Many of the cases which are considered *congenital* are, according to Little, due to injuries received during birth. When both sterno-cleido-mastoid muscles are involved, the affection will usually be found to have a rheumatic origin.

Symptoms and Diagnosis.—The *symptoms* are easily recognized, the contracted muscles being tense and well defined; frequently both portions of the sterno-cleido-mastoid seem equally rigid, but often the sternal portion is alone or principally involved. The *diagnosis* is usually easy; the deformity may be closely simulated by the contraction of a cicatrix after a burn, or by disease of the cervical vertebræ; in the former event, the nature of the case will be evident upon careful examination, while if spinal disease be present, the fact can be ascertained by observing the localized tenderness on pressure, and the pain produced by moving the spine or by pressing the head downwards, with perhaps the existence of inflammatory thickening and of partial motor paralysis.

Treatment.—In the milder form of the affection, especially when of a rheumatic origin, a cure may be sometimes effected by the use of anodyne and stimulating embrocations, the external application of heat, or, as successfully practised by Dr. J. M. Da Costa, of this city, by the hypodermic use of atropia; in some cases, in which the disease would appear to consist not so much in spasmodic contraction of the muscles on one side as of paralysis of those on the other, benefit may be derived from the employment of electricity, or from the endermic application of strychnia. Busey, of Washington, employs hypodermic injections of morphia, and enforced motion of the affected muscles while the patient is under the influence of ether. In severer and more obstinate cases, it will usually be necessary to resort to an operation, though if the degree of contraction be not very great, mechanical extension, by means of a suitable instrument, will occasionally suffice.

The *Operative Treatment* of wry-neck consists in the subcutaneous division of one or both of the lower attachments of the affected sterno-cleido-mastoid muscle: the *sternal* portion may be divided by introducing an ordinary tenotome in front of the upper margin of the sternum, and about half an inch above the line of the clavicle, and, having passed the knife behind the tendon, with its flat surface towards the latter, turning the edge forwards, and cutting the muscle, which is previously rendered tense, with a slight sawing motion from behind forwards. The *clavicular* attachment may be divided by a similar operation, through a puncture made at its posterior edge; or, which is perhaps safer, a small incision may be made down to the clavicle, between the two portions of the muscle, and the clavicular attachment then cut from behind forwards, with a delicate probe-pointed tenotome which is cautiously insinuated between the muscle and the bone, As soon as the tendons have been divided, the punctures should be closed with a little dry lint and an adhesive strip, the patient being then placed in bed with the head well supported; after a few days an apparatus may be applied to effect mechanical extension, while the cure is further promoted by the systematic employment of friction and passive motion. The operation for wry-neck is one of much delicacy, and not free from risk, the principal danger being from the possibility of wounding the external or internal jugular vein, or the carotid artery; that this risk is not merely imaginary is shown by the fact that, in more than one case, the operation has been followed by fatal hemorrhage.

FIG. 323.



Tenotome.

Various forms of mechanical apparatus are employed in the after-treatment of wry-neck; in young subjects, it may sometimes be sufficient to apply a broad adhesive strip around the forehead and occiput, and another around the waist, fastening the two together by means of a bandage or elastic band carried from above the the ear of the unaffected side across the chest to the opposite side of the trunk, thus reinforcing the healthy sterno-cleido-mastoid muscle, and so causing the disappearance of the wry-neck. A more elegant appliance is that of Jörg, which consists of a leather corset and firm head-band, connected by a steel rod worked by a rachet-wheel and key. Swan substitutes for the corset a plaster-of-Paris jacket. Other efficient forms of apparatus act by means of two levers, one pressing on the side of the chin, and the other on the opposite temple.

Wry-neck accompanied with Painful Convulsive Spasm of the Affected Muscles is a very intractable form of the disease, and occurs chiefly in female adults. Here division of the sterno-mastoid muscle affords, usually, only temporary relief. Dr. Little has several times obtained a cure by the administration of the bromide of potassium, or of the corrosive chloride of mercury, with attention to the digestive functions: and in other cases, portions of the spinal accessory nerve have been excised with benefit by Campbell De Morgan, Annandale, Rivington, and Tillaux. The same nerve has been stretched in two cases by Southam, of Manchester; in one with permanent, but in the other with only temporary, benefit. Another cure by nerve-stretching is attributed to Mosetig-Moorhof, of Vienna. The actual cautery has proved effective in the hands of Dr. C. K. Mills.

Lateral Curvature of the Spine.

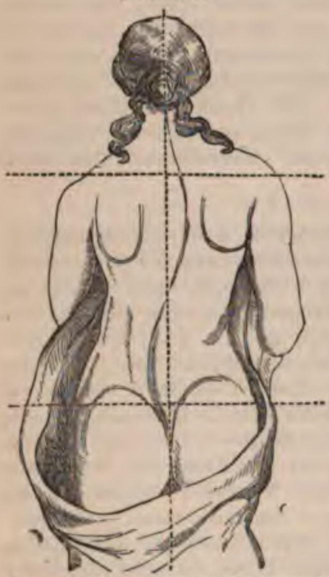
This affection, which appears, in the majority of cases, to depend simply upon relaxation and debility of the spinal ligaments and muscles, is most common in young girls of from twelve to eighteen years of age. There are usually two curves, one occupying the dorsal region, and in most instances presenting its convexity to the right side, and the other or compensatory curve in the lumbar region, and convex to the left. More rarely there are four curves, an upper and a lower dorsal, and an upper and lower lumbar. Together with the lateral curvature, there is always a rotation of the bodies of the vertebræ on their axis, this rotation or twisting taking place in the direction of the convexity at each portion of the curve. The *bodies* of the vertebræ are thus more displaced than the *spinous processes*, which, as pointed out by Judson, of New York, are held in place by their lateral attachments, and which sometimes appear, even in advanced cases, to occupy almost their natural line. The disease affects at first only the ligaments and muscles of the spine, but, in long-continued cases, may give rise to compression or partial absorption of the intervertebral cartilages, or even of the bones themselves. As the result of the twisting of the vertebræ which accompanies the *lateral* displacement, a certain degree of *antero-posterior* curvature is sometimes superadded—a rounded or hump-like projection occurring in the dorsal region, with a corresponding incurvation of the lumbar spine, the former constituting the condition known as *cyphosis*, and the latter that called *lordosis*. These are, indeed, but exaggerations of the natural curves met with in every adult spine. In some cases, especially among rachitic persons, they may exist without lateral displacement. Dr. Tuckey, an Irish physician, has described, under the name of *acute lateral curvature*, a condition which seems analogous to the so-called "hysterical" joint-affections described in Chapter XXXI.

Causes.—The common cause of lateral curvature is, as already mentioned, simply debility of the ligamentous and muscular structures which normally support the vertebral column, thus allowing, as it were, the head and upper part of the body to settle downwards, and necessarily forcing the relaxed and weakened spine to yield at its least-resisting point. The physiological changes which occur in the female at the age of puberty, and the customary relinquishment, at that period of life, of the out-door sports of childhood, appear to act as powerful predisposing causes of the spinal relaxation referred to. The very constant character of the displacement—to the right in the dorsal and to the left in the lumbar region—is doubtless due to certain vicious habits and postures, such as supporting the whole weight on the right leg ("standing at ease," in the language of the drill-master), whereby the pelvis is rendered oblique, and the lumbar spine necessarily distorted to the left side; to sitting habitually at a desk with the left shoulder depressed and the right elevated; to over-exertion of the right arm in sewing, etc. Though the dorsal curve is usually most apparent, it is really, according to Shaw, preceded in time of formation by the lumbar. The latter, however, does not become so quickly permanent, on account of the greater flexibility and elasticity of the part, which enable it to resist longer the occurrence of absorption of the articular processes and other secondary changes than can be done by the dorsal spine, fixed as that is by its connections with the thoracic walls. According to Willett, both curves are developed simultaneously.

Among the rarer causes of lateral spinal curvature may be mentioned *obliquity of the pelvis* from any circumstance, as from anchylosis of the hip-joint after hip disease (here the deformity is principally of the variety called *lordosis*), and distortion resulting from *contraction of one side of the chest* after empyema or chronic pleurisy. *Inequality in the length of the lower limbs* is, according to Barwell, a frequent cause of lateral curvature.

Symptoms.—The symptom of lateral curvature which first attracts attention is commonly a projection or "growing out" of the right scapula, often attended with pain in the shoulder and back; this is usually worse while sitting, or upon first lying down, so that a patient who has made no complaint during the day may lie awake in pain for several hours upon going to bed at night. Upon making an examination, the surgeon will readily perceive the wing-like projection of the scapula, and may, even at this early stage, recognize a slight deviation in the line of the vertebræ, by tracing down the spinous processes and marking each with pen and ink. It must be, moreover, remembered that the deviation of these processes by no means represents the degree of distortion of the bodies of the bones, the displacement of the latter being, I believe, invariably greater than that of the former. In the early stages of the affection, the deformity can be made to disappear by laying the patient on a bed in the prone position and making slight extension on the spine; but in advanced cases the deformity will persist in all positions, while the whole chest and the pelvis may be likewise markedly distorted, and serious functional disturbance, or even organic disease, may result from the consequent compression of the thoracic, abdominal, or pelvic viscera.

FIG. 324.



Lateral curvature of spine. (ERICHSEN.)

Diagnosis.—Lateral curvature may be distinguished from the graver condition known as *antero-posterior curvature*, or Pott's disease of the spine (which will be described hereafter), by the fact that in the latter affection the displacement is commonly angular, rarely lateral, and unattended with axial rotation of the vertebræ. There are besides, usually, marked immobility, thickening, and tenderness of the affected portion of the spine. From the spinal distortion of *rickets*, lateral curvature may be distinguished by observing the different ages at which the diseases respectively occur, and by noting that in rachitis the primary displacement is antero-posterior, the lateral deformity, if there be any, being a mere coincidence; while in the true lateral curvature the fact is exactly the reverse, cyphosis and lordosis being in these cases secondary phenomena.

Treatment.—No matter how slight the deformity in any case may appear to be, it should not be neglected: in the early stages, before any structural alteration has occurred, it may be possible to effect a complete cure; but at a later period the most that can be done is to prevent further increase of the deformity. The treatment consists in the adoption of measures to improve the general health, the administration of *tonics*, especially iron and quinia, and the *abandonment of any injurious habit or occupation*. The patient should take *exercise* in the open air, and may often derive great advantage from *gymnastics*, swinging by the hands from bars placed above the head, the use of light dumb-bells, etc. The object is to put in motion and thus to strengthen the various muscles attached to the spinal column, and much ingenuity may be exerted in devising various modes of accomplishing this purpose. None of these exercises should, however, be persevered in to the extent of producing fatigue. During the intervals of exercise, the patient should be encouraged to keep the *recumbent posture*, lying upon a firm mattress or sofa with a single pillow, so as to relieve the vertebral column from pressure. If the curvature persist while lying down, a *cushion* may be placed under the projecting portion of the spine, so as gradually to press the bones into their normal position. *Friction* of the muscles on either side of the spine, either with the hand alone or with stimulating liniments, will often be of service, as will also the daily use of the *cold salt douche*. In severer cases it will probably be necessary to afford *mechanical support* by means of some form of apparatus. A great many instruments have been devised for this purpose, the general principle of action being to elevate the shoulders by means of crutch-heads under the axillæ (connected with a well-padded pelvic collar), with side-pieces to support and gradually replace the projecting vertebræ by applying pressure to the corresponding portions of the chest-walls. Such an apparatus should be, as a rule, worn during the day only. Prof. Sayre has recommended the use of a plaster-of-Paris bandage, applied while the spine is made as straight as possible by suspending the patient by his head and arms. The suspension itself may also prove of service, as was pointed out by Glisson in the seventeenth century. My own judgment in regard to the plaster dressing in lateral curvature is that, while in some very bad cases it is capable of affording a certain measure of relief, it is ill adapted for the large majority of cases, as unnecessarily and even injuriously confining the chest and interfering with the action of the muscles; hence, for all ordinary cases of lateral curvature, I prefer a light metallic support to a plaster jacket. Even for the very bad cases, a moulded leather splint is in some respects better than the plaster bandage, or, which Mr. Adams prefers, a splint made of "poroplastic" felt.

If a case of lateral curvature be recognized at an early period, and promptly and judiciously treated, it may be, if not cured, at least kept in check until the critical period of adolescence has passed by, when there will be comparatively little tendency to increase of the deformity. It thus happens that, while a very large number of young girls suffer from incipient lateral curvature, its advanced stages are comparatively seldom seen—the disease being, as it were, "outgrown" in a great many instances.

Myotomy, or subcutaneous division of the spinal muscles and aponeuroses, for a long time almost entirely abandoned in the treatment of lateral curvature, has been revived by Prof. Sayre, of New York, who has in several cases divided the latissimus dorsi with alleged immediate benefit. I confess that the operation seems to me unnecessarily heroic, and, indeed, as the disease is mainly dependent upon ligamentous and muscular *relaxation*, not contraction, I do not understand why such a procedure should be expected to prove ultimately successful.

DEFORMITIES OF THE UPPER EXTREMITY.

Contraction of the Shoulder.—Duplay has described, under the name of *scapulo-humeral periarthritis* (see page 611), an affection which consists in inflammatory thickening of the sub-acromial bursa and sub-deltoid areolar tissue, with the formation of adhesions which interfere with the motions of the humerus. The extra-articular character of the affection can be recognized by observing the localization of the pain and swelling in the sub-acromial region. The *treatment* consists in forcibly rupturing the adhesions while the patient is under the influence of an anæsthetic, and in the subsequent employment of passive motion, friction, galvanism, and the cold douche. Gosselin has described a similar condition as occurring in the knee.

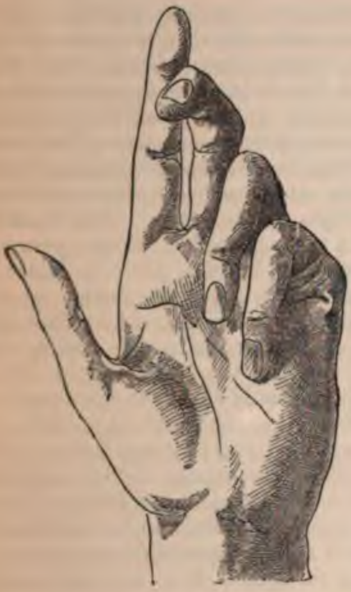
Contraction of the Elbow, apart from disease of that joint, may be owing to the retraction of the cicatrix of a burn, or to a contracted state of the biceps muscle—which latter condition may itself be variously due to *hysteria*, to *rheumatism*, or to *constitutional syphilis* (see pp. 461, 519). In *hysterical* cases, the proper constitutional treatment for that condition should be employed, the arm being, if necessary, extended while the patient is in a state of anæsthesia, and then kept in a straight position for a few days. In the *rheumatic* form, when the contraction is permanent and accompanied with organic change, *tenotomy* may be required. The operation is performed by slipping a tenotome flatwise beneath the tendon of the biceps from within outwards, so as to avoid the artery, and then, turning the edge of the knife forwards and upwards, effecting the section by cutting with a slight sawing motion while the arm is forcibly extended. The wound should then be closed and the arm placed in a sling, extension being applied after a few days by means of a screw-splint or weight.

Contraction of the Forearm and Hand is occasionally met with as the result of excessive use of certain muscles, with disuse of others: the *treatment* consists in a change of occupation, with the employment of a straight splint, friction, galvanism, etc.

Club-Hand is a rare affection, analogous to club-foot. It is usually complicated with a deformed condition of the lower end of the radius, and sometimes of the carpal bones. Two forms of club-hand are met with, in one of which the part is in a state of extreme flexion, and in the other of extension. The affection is sometimes congenital, but usually results from infantile paralysis, and is, according to Holmes, always accompanied by other deformities. The *treatment* consists in supplementing the action of the paralyzed muscles by means of India-rubber bands, attached to a light metal frame, and passing beneath a ring at the wrist. In inveterate cases, tenotomy may be required, followed, after the healing of the wound, by passive motion, aided by the use of friction and galvanism.

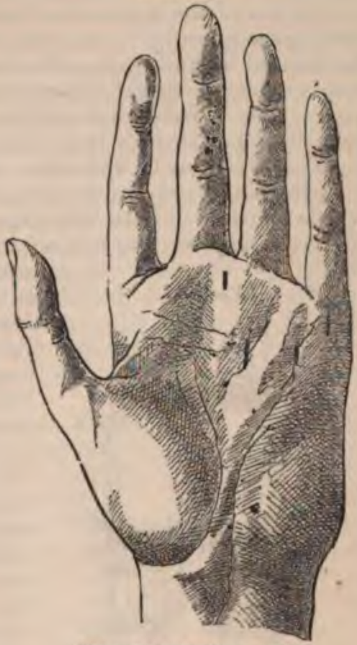
Contraction of the Fingers into the palm of the hand is not unfrequently met with, usually in old persons, as the result of an indurated state of the palmar and digital fascia, due apparently to a gouty condition or to one analogous to that of rheumatoid arthritis. The exciting cause of the affection (which was first well described by Dupuytren) is often the habitual pressure of the head of a cane, or of the handles of various kinds of tools. A similar contraction may be due to burns or other traumatic causes (in which case a scar would be perceptible), or to certain forms of *eczema*—an important point to be remembered, as the operation about to be described would not of course be applicable to that affection. The best *treatment* of the deformity now under consideration consists in the cautious subcutaneous division of the contracted fascia, which may be effected by slipping a very small flat-edged tenotome beneath the skin—between it and the fascia—and cutting downwards; the part should then be immediately extended, and kept in the straight position by means of a light splint worn continuously for three weeks, and afterwards, only at night, for several weeks longer. This plan, which is that advised by Mr. Adams, I myself resorted to with most gratifying success in a case from which the annexed illustrations are taken (Figs. 325, 326). Busch and Madelung advise that a triangular flap of skin should be dissected up, and the palmar fascia notched at every point at which it seems tense; the flap is then to be replaced, and, when the wound has united, mechanical extension resorted to. Post divides the contracted fascia by direct incision, and, like Adams, lays stress upon the importance of making *immediate* extension.

FIG. 325.



Dupuytren's finger contraction.

FIG. 326.



The same hand after operation.

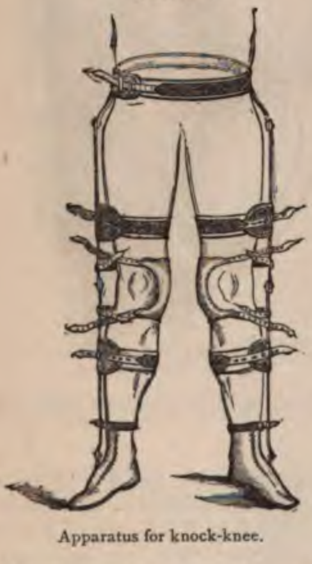
Webbed Fingers.—This annoying deformity may be remedied by perforating the base of the web and allowing the parts to cicatrize around a metal ring, when the rest of the web can be divided without risk of readherence; by a plastic operation, as employed by Barwell (who transplanted flaps for the purpose from the patient's buttock), by Harris, of New Jersey (who utilized for the purpose a strip of skin taken from the web itself), and by A. T. Norton (who loosens a tongue of skin from between the knuckles, and another from the palm, and, after dividing the web, brings these together with sutures); or by the use of the elastic ligature, as recommended and successfully employed by Vogel, of Eisleben.

DEFORMITIES OF THE LOWER EXTREMITY.

Contraction of the Hip.—Contraction of the muscles surrounding the hip may occasionally require tenotomy or myotomy, in cases of spasmodic rigidity of the lower extremities, of congenital luxation, or of chronic hip disease. The tendon which most often requires division is that of the adductor longus, though the operation is also sometimes performed upon the adductor brevis, pectineus, tensor vaginæ femoris, and rectus. Division of these muscles is performed in accordance with the principles of tenotomy in general, the knife being introduced behind the part to be divided, and the section then cautiously effected by cutting from behind forwards.

Knock-knee or Genu-valgum is a not uncommon deformity, consisting of a relaxation of the ligamentous and muscular structures of the knee-joint, allowing the articulation to yield in a direction inwards and backwards. The internal lateral ligament is elongated, while the external lateral ligament is rendered tense, together with the vastus externus and outer hamstring tendon. The inner condyle of the femur is, as compared with the outer, disproportionately large and prominent, while the popliteal space is somewhat obliterated. The affection is probably never congenital, but comes on during childhood, and is apparently connected in many instances with a rachitic tendency. Both knees are usually simultaneously affected, though the disease may be more marked in one than in the other. The *treatment* consists in the adaptation of an apparatus such as is shown in Fig. 327. An iron rod, hinged at the hip, knee, and ankle, extends from a pelvic band to the sole of the shoe, and is provided with pads, straps, and buckles, by which the knee may be drawn outwards: in severe cases, motion should be permitted at the hip and ankle only, the knee being fixed, and its displacement gradually rectified by means of the adjusting straps or a ratchet-screw. Division of the external hamstring tendon is occasionally resorted to as a preliminary measure, but, according to Little, does not appreciably hasten recovery, and is therefore not to be recommended. Forcible straightening of the limbs is a favorite mode of treatment with French and German surgeons, but, according to De Santi, should only be employed in rachitic cases, and never at a later period of life than 14 years. Little, Schede, and Annandale have, in aggravated cases, straightened the limbs by excising wedge-shaped pieces of bone, the two former from the tibia, and the latter from the condyles of the femur. Schede also divided the fibula with a chisel. Exision of the knee-joint has in a similar case been successfully resorted to by Mr. Howse. Ogston simply saws through the projecting condyle and forcibly straightens the limb, while a similar operation with the chisel and with antiseptic precautions is practised by Barwell. Reeves and Chiene employ operations of like character, but avoid opening the joint, and thus make the section *extra-articular*. The first-named surgeon simply divides the condyle, or, as he has latterly recommended, the shaft of the femur itself, just below its middle, while the latter removes from the condyle a wedge-shaped portion of bone. McEwen, of Glasgow, divides with a chisel or osteotome the inner two-thirds of the femoral diaphysis, just above the condyles, and then straightens the limb by bending or breaking the remainder. None of these operations can be considered entirely free from risk, though their results have been upon the whole very satisfactory, 256 cases operated on by one or other method having furnished, according to Poore, of New York, only 4 deaths, while McEwen alone

FIG. 327.



Apparatus for knock-knee.

reports 367 operations on 220 patients, with only 3 deaths, and these from independent causes.

Outward Bowing of the Knee or Genu-Extrorsum is a condition which is the reverse of *Genu-Valgum;* the external lateral ligaments are relaxed, and the tibiæ themselves are commonly curved, giving the appearance known as "*bow-legs*." This deformity is sometimes traceable to premature attempts at walking, and is usually connected with a rachitic vice of constitution. The *treatment* consists in the application of padded splints, so as to overcome the outward bending of the limbs, and, at a later period, in the adaptation of suitable supports, so as to prevent a recurrence of the deformity. Mr. Marsh recommends forcible straightening of the curved tibiæ, or even partial division of these bones, with a narrow saw, and fracture of the remaining fibres and of the fibulæ, and reports several cases in which this apparently severe operation was resorted to with good results. A similar mode of treatment has been successfully resorted to by Billroth, McEwen, and Poore, who, however, employ a chisel instead of a saw. McEwen has performed ten osteotomies on the same patient, both femora, and both tibiæ and fibulæ (the latter at both upper and lower ends), being divided at one operation.

Contraction of the Knee, dependent upon shortening of the hamstrings, may occur in connection with anchylosis of the joint, or independently: the treatment consists in division of the hamstring tendons, followed by gradual extension, with passive motion, friction, etc.

Division of the Hamstring Tendons is thus performed: the patient being in the prone position, an assistant renders the parts tense by fully extending the limb, and the surgeon then introduces the tenotome flatwise on the *inner* side of the *outer* hamstring, or *biceps* tendon (which is to be first divided), through a puncture which in the adult should be an inch above the point at which the tendon joins the fibula. By keeping the knife close to the tendon, the risk of wounding the peroneal nerve is avoided, and the section is then effected by cautiously cutting towards the skin. The *semi-tendinosus,* being superficial and prominent, is readily divided, but the *semi-membranosus* requires a freer use of the knife: it, however, comparatively seldom needs to be cut. In operating on the *inner* hamstrings, the tenotome should be introduced close to the *outer* (popliteal) side of the semi-tendinosus, as there is thus less risk of wounding the important structures in the popliteal space. After the operation, the wounds should be instantly closed with a firm compress (to prevent extravasation, or the entrance of air), and no attempt at extension should be made until the parts are entirely healed, which usually requires a delay of four or five days. Neglect of this precaution may give rise to wide-spread suppuration in the tissues of the ham.

When cicatrization has occurred, gradual extension may be made by means of a weight, elastic bands, or screw apparatus, or in some few cases forcible extension may be preferably employed, the patient being, of course, in a state of anæsthesia. Recovery may be further promoted by the assiduous practice of passive motion, aided by friction, douches, etc.

Club-Foot.—*Talipes* or *Club-foot* is a common deformity, which may affect one or both extremities, and may occur in either sex, though more frequently in boys than in girls. It may be *congenital* or *acquired.* There are four *primary* and as many *secondary* varieties of the deformity. The primary forms of club-foot are *Talipes Equinus, Talipes Calcaneus, Talipes Varus,* and *Talipes Valgus,* while the secondary forms are combinations of these, receiving the names of *Equino-Varus, Equino-Valgus, Calcaneo-Varus,* and

Calcaneo-Valgus. All forms of club-foot depend upon contraction of various muscles and tendons, which may result from spasm of the contracted parts themselves, or from paralysis of the antagonistic muscles; in most cases the bones of the foot are not altered in structure, but in inveterate cases of varus (which is the most common form of congenital talipes), the astragalus, scaphoid, and cuboid will all be found more or less atrophied and twisted, the ligaments correspondingly altered in length, the tendons distorted, and the muscles of the whole limb wasted. Adams, indeed, maintains that, in cases of varus, the astragalus is malformed from the moment of birth, the malformation probably being due to the pressure of the adjacent bones during intra-uterine life. In non-congenital club-foot, the muscles commonly undergo fatty degeneration, rendering prognosis in these cases less favorable than in those which are congenital.

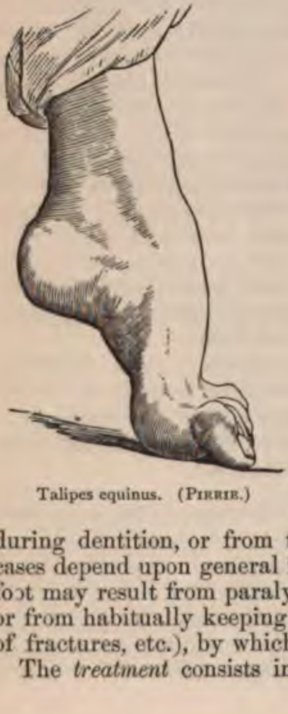
The first application of *tenotomy* to the cure of club-foot was an operation performed by Lorenz, in 1784, on the recommendation of Thilenius, of Frankford. The operation consisted in a simple incision, involving the skin and subjacent tissues as well as the contracted tendon, and a perfect cure is said to have been obtained. Delpech, in 1816, transfixed the limb beneath the tendo Achillis, and cut towards the skin, which was, however, carefully protected from injury. To Stromeyer, of Hanover, in 1831, is due the credit of first resorting to subcutaneous tenotomy as it is now practised, while to Guérin and Bonnet, in France, to Little, Tamplin, and Adams, in England, and to Detmold and Mütter, in this country, are in a great measure owing the general introduction and perfection of the procedure.

The *process of repair* after division of tendons consists, as shown by Adams, in the development, between the retracted ends, of a new material, which does not, as was formerly supposed, subsequently contract and bring down the shortened muscle, but remains permanently, though gradually assimilating itself in structure and appearance to the original tendon.

1. *Talipes Equinus.*—This is very seldom, if ever, a *congenital* affection, but is, on the other hand, the most common *non-congenital* form of club-foot, occurring, according to Tamplin, in forty per cent. of cases originating after birth, and in twenty-two and a half per cent. (or according to Lonsdale and Adams, thirty-four per cent.) of all cases taken indiscriminately. The deformity in talipes equinus consists simply in an elevation of the heel, which may be so slight as merely to prevent the foot from being flexed beyond a right angle, or may be so marked as to force the patient to walk upon the toes and extremities of the metatarsal bones, as seen in Fig. 328.

The *cause* of this deformity (in children) is very often disturbance of the nervous system during dentition, or from the irritation of intestinal worms, though some cases depend upon general infantile paralysis; in adults, this form of club-foot may result from paralysis, from abscess or injury of the calf of the leg, or from habitually keeping the foot in a bad position (during the treatment of fractures, etc.), by which the patient acquires a "pointed toe."

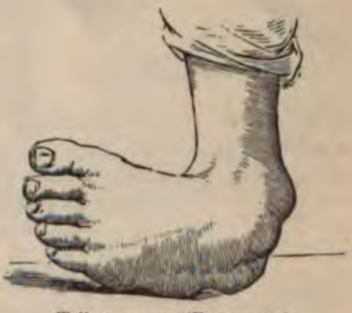
FIG. 328.



Talipes equinus. (PIRRIE.)

The *treatment* consists in the *subcutaneous division of the tendo Achillis,* about an inch above its point of insertion. The patient being prone, and the tendon rendered tense by depressing the foot, the tenotome is introduced flatwise (on either side, as most convenient), and carried across in close contact with the tendon, so as to avoid wounding the posterior tibial artery; the edge of the knife being then turned backwards, the tendon is forcibly brought against it by still further depressing the foot, while the blade is given a slight sawing motion. An audible snap usually marks the completion of the operation, when the heel can be immediately brought down an inch or two further than before. Prof. J. Pancoast has in some cases advantageously substituted *division of the lower portion of the soleus muscle* for that of the tendo Achillis. In very severe cases of talipes equinus, it may be necessary to divide the *plantar fascia*, or even some of the *tendons of the toes*, as well: when the plantar fascia is to be divided, this should be done as a preliminary operation, the tendo Achillis being for the time untouched, so that its tense condition may fix the heel and facilitate the "unfolding" of the arch of the foot. After the operation, the punctures made by the tenotome should be immediately closed with a piece of lint dipped in the compound tincture of benzoin, and an adhesive strip. *Mechanical extension* may be begun from the third to the fifth day (not before the former[1]), and may be conveniently effected by Adams's modification of Scarpa's shoe, which differs from those in ordinary use, chiefly in having a transverse division of the sole-plate, corresponding to the transverse tarsal joint. In using this, as with all other forms of orthopædic apparatus, care must be taken to guard against excoriation, by frequently removing the instrument and bathing the skin with some stimulating lotion. The extension must be effected *very gradually*, the maxim "*festina lente*" being in no cases more important than in these.

FIG. 329.



Talipes varus. (FERGUSSON.)

2. *Talipes Varus* is the most frequent variety of *congenital* club-foot, being met with, according to Tamplin, in ninety per cent. of such cases. The deformity of varus is twofold, consisting in an *inversion* of the anterior two-thirds of the foot, which rotates upon a centre of motion constituted by the astragalo-scaphoid and calcaneo-cuboid joints, with an *elevation* of the posterior third by the contraction of the muscles of the calf. When the latter displacement is particularly marked, the affection receives the name of *equino-varus*. The *inversion* of the front part of the foot is due to contraction of the tibialis anticus, tibialis posticus, flexor longus digitorum, and occasionally the flexor and extensor longus pollicis, the plantar fascia and flexor brevis digitorum being also sometimes more tense than in the normal state.

The treatment of this form of club-foot is best divided into two stages, the inversion of the front of the foot being remedied during the first, and the elevation of the heel during the second, stage; in other words, the case is first to be converted into one of simple talipes equinus, and then treated as was directed in speaking of that form of the affection. In some very slight cases of congenital varus, the deformity can be remedied by simple manipulation and friction repeated several times a day, but in cases of ordinary severity, *tenotomy* should be resorted to, the best age for the operation being probably between the second and third months of life. The tendons to be divided in the *first* stage of treatment, are those of the tibialis anticus and posticus, with sometimes that of the flexor longus digitorum, and the plantar fascia. Buchanan of Glasgow, advocates division of the muscular substance of the abductor pollicis. The tibialis anticus tendon deviates from its normal direction, curving downwards and backwards across the inner malleolus, while the posterior tibial tendon passes from behind the inner ankle directly downwards, or even with a slight backward obliquity. In dividing the latter tendon, there is some risk of wounding the posterior tibial artery; hence it is well to adopt Tamplin's suggestion of making a preliminary puncture, and then using a blunt-pointed tenotome. Should the vessel be wounded, it should be cut completely across, and a firm compress and bandage then instantly applied. If a traumatic aneurism form, it may be treated by compression, by injection of the perchloride of iron, or by the "old operation." Similar treatment would be required if the internal plantar artery should be wounded in dividing the plantar fascia. After tenotomy, the inversion of varus may be slowly overcome by bandaging the limb to a straight external splint, or by the use of a "varus shoe," provided with a joint in the sole-plate for effecting eversion (Fig. 330). The *second* stage of treatment consists in dividing the tendo Achillis, and in subsequently bringing down the heel, as in a case of simple talipes equinus. The *time* required for the cure of talipes varus varies from two months to a year, according to the age of the patient and the severity of the affection.

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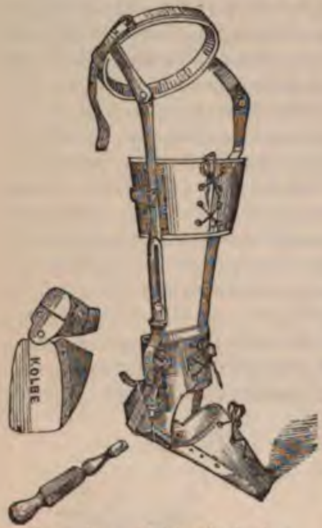
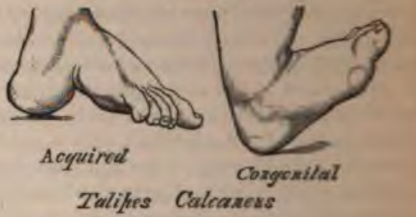
[1] I believe this to be the best plan when the surgeon can watch the application of the apparatus during the whole course of after-treatment; but when this is impossible, I have of late years found it more satisfactory to restore the foot at once to the normal position, and then apply a plaster-of-Paris bandage. The shoe can be adjusted a week or ten days subsequently, when there will be but little tendency to recontraction.

FIG. 330.



Varus shoe, with jointed sole-plate.

FIG. 331.



(BRYANT.)

Excision of the cuboid bone, suggested by Dr. Little and first practised by Mr. Solly in a case of talipes varus in an adult, has been lately revived with good result in several cases by Mr. R. Davy, and the same surgeon as well as Bryant, J. F. West, W. H. Bennett, and König have further extended the operation to removal of a wedge-shaped portion of the tarsus.[1] Davies-Colley has, in a case of varus, excised the cuboid, with portions of the astragalus, calcis, scaphoid, cuneiforms, and outer metatarsals; while Lund, of Manchester, has in a similar case successfully excised the astragalus on both sides. Mason, of New York, has excised the astragalus and external malleolus for equino-varus, but sloughing and hemorrhage followed, and amputation was performed with a fatal result. The astragalus has also been excised for club-foot (successfully) by Verebélyi, and the cuboid (also successfully) by Poinset.

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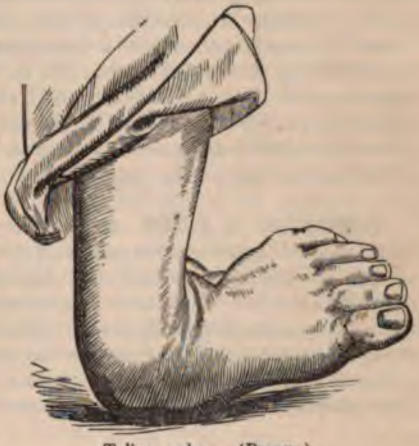
[1] Davy reports 17 operations of this kind upon 14 patients, with only one death.

3. *Talipes Calcaneus* (Fig. 331) is very rare as a congenital affection, though as a non-congenital disease, resulting from infantile paralysis (particularly in combination with talipes valgus), it is, according to Adams, comparatively common. This form of club-foot depends upon contraction of the muscles of the front and outer part of the leg, the deformity, which is the reverse of talipes equinus, causing the patient to walk on the heel. In slight cases of the congenital variety, a spontaneous cure may be effected by the simple process of walking, but in most instances, tenotomy will be required, the tendons to be divided being those of the tibialis anticus, extensor communis digitorum, extensor proprius pollicis, and peroneus tertius. The after-treatment consists in the application of an apparatus provided with an elastic spiral spring at the heel, to supplement the action of the tendo Achillis. Willett recommends resection and "splicing" of the latter tendon, and records three cases in which this operation was advantageously resorted to. This form of talipes is occasionally combined with varus, constituting *calaneo-varus.*

FIG. 332.



Talipes valgus. (PIRRIE.)

4. *Talipes Valgus,* or *flat* or *splay-foot,* is rare as a congenital, but sufficiently common as an acquired, affection. The deformity is here the reverse of that seen in varus, the sole being flattened, the arch of the instep obliterated, and the foot everted. In severe cases, the heel is commonly depressed as well, constituting *calcaneo-valgus;* or, on the other hand, the heel may be elevated, constituting *equino-valgus.* Congenital cases of talipes valgus may often be cured by simple manipulation, or by bandaging the foot to an inside splint with a wedge-shaped pad, as in Dupuytren's mode of treating fractured fibula. In other instances, tenotomy will be required, the parts to be divided being the tendons of the peroneus longus and brevis, extensor longus digitorum, and peroneus tertius, with sometimes the tendo Achillis, or even the tendons of the tibialis anticus and extensor pollicis. The first-named tendons may be divided about an inch above the external malleolus, and the flexors in front of the ankle-joint. The after-treatment consists in applying an apparatus to produce gradual *inversion,* with a pad to restore the arch of the foot.

Weak Ankles, which often precede the development of acquired talipes valgus, should be treated by attention to the hygienic surroundings of the patient, and by the use of friction and the salt douche, with, if necessary, an elastic bandage, or light metallic lateral supports.

On the Treatment of Club-foot without Dividing Tendons.—Mr. Barwell opposes the practice of tenotomy, in the treatment of talipes, on the ground that the affection is always the result of paralysis, and that divided tendons seldom reunite. He recommends instead, the employment of an apparatus in which elastic cords supplement the paralyzed muscles, and counteract the action of those which are contracted. Without entering into any discussion of Mr. Barwell's theoretic views (which are opposed to those of the leading authorities on the subject of club-foot), it will be sufficient to say that, while the ingenious mode of treatment which he advocates may undoubtedly effect a cure in mild cases, it will, as undoubtedly, fail in many of those which are more severe; and even in the slight cases, tenotomy (which has not been proved to do any harm) certainly abbreviates the time required for treatment. Indeed, we may safely say, in the words of Mr. Adams, that the successful treatment of club-foot demands, in most cases, "a judicious combination of operative, mechanical, and physiological means." The chief advocate of Mr. Barwell's views, in this country, is Prof. Sayre, of New York, who is however too judicious a surgeon to recommend Barwell's plan as an exclusive mode of treatment. Prof. Sayre's rule for determining whether or not a tendon should be divided, is to anæsthetize the patient and then, having put the parts on the stretch, to press with the finger or thumb on the stretched tendon; if this pressure produce reflex contractions, tenotomy is required.

Dr. Newton M. Shaffer, of New York, has devised an ingenious apparatus for applying *traction* to the anterior part of the foot, and thus aiding in unfolding the tarsal arch; Dr. J. C. Hutchison and Mr. H. A. Reeves recommend the use of plaster-of-Paris bandages in the after-treatment of club-foot, and I have myself frequently followed this plan with good results in cases in which the patients were not going to remain under my constant supervision. (See *note*, page 651.)

Contraction of a Toe, usually the second, is commonly due to a tense state of the digital prolongation of the plantar fascia, and requires division of the offending structure; the operation should be done subcutaneously, opposite the base of the second phalanx, the toe being then straightened, and secured to a small pasteboard or wooden splint. According to Nunn, some cases of contracted toe (*hammer toe*) are of spinal origin.

Contraction of the great toe, sometimes called *Hallux valgus*, has already been referred to in speaking of *bunion* (p. 524).

CHAPTER XXXIV.

DISEASES OF THE HEAD AND SPINE.

Diseases of the Head.

Tumors of the Scalp.—The most common forms of tumor met with in the scalp are the *cutaneous proliferous cyst* and the *vascular* or *erectile tumor*, though *fatty* and *fibrous* growths have also been occasionally seen in this situation. The *treatment* of these affections has been sufficiently discussed in other parts of the volume.

Tumors of the Skull.—*Bony*, *cartilaginous*, *myeloid*, and *cancerous* growths are met with in the cranial walls, the latter form of disease constituting the affection sometimes described as *Fungus of the Skull*. Surgical interference is rarely admissible in this serious condition, though a case is referred to by Erichsen, in which such a growth was successfully removed by B. Phillips.

Fungus of the Dura Mater.—Under this name is commonly described a tumor which, beginning without any obvious cause, makes its appearance on the top or side of the head, or in the temporal region, forming a semi-fluctuating mass, sometimes crackling on pressure, pulsating, attended with much pain, and accompanied with various cerebral symptoms, such as double-vision, deafness, convulsions, and, in the latter stages, coma and paralysis. The tumor, as it increases, becomes softer and more prominent, a distinct margin of bone being often felt surrounding the morbid growth, indicating the occurrence of erosion of the skull. The pathology of this serious affection, which was first clearly described by Louis, has been recently investigated by Mr. Lawson Tait, who concludes, from the dissection of a case which came under his own observation, as well as from the recorded histories of other instances of the disease, that the so-called fungus of the dura mater is really an affection of the skull, originating in the layers of osteal cells, and, clinically speaking, of a malignant character. The disease may originate either beneath the pericranium (outside the skull), or between the cranial wall and the dura mater, or, as happened in Mr. Tait's own case, in both situations simultaneously, the skull thus undergoing erosion on both sides, until the masses meet and amalgamate, when pulsation is developed.

The *Diagnosis* from vascular tumor of the scalp, which is the only disease with which the affection is likely to be confounded, may be made by observing that the growth cannot be moved laterally upon the skull, and (in cases in which the bone is perforated) can be often partially reduced within the cranial cavity. A fungus of the dura mater has been punctured under the impression that it was an abscess, but such a mistake could scarcely arise except through carelessness.

The *Treatment* of this affection is extremely unsatisfactory: Louis recommends that the growth should be excised, or otherwise extirpated, after removing as much of the skull as may be necessary with the trephine; but the case which he gives of recovery after this severe treatment, seems, as justly remarked by Holmes, to have been really one of simple caries with underlying exuberant granulations. Any partial operation, in view of the malignant character of the affection, would be worse than useless, while complete extirpation would, in all probability, but hasten the fatal issue.

Fungus of the Brain, or *Hernia Cerebri*, has been sufficiently alluded to in a previous portion of the work. (See page 323.)

Encephalocele, Meningocele, etc.—These are the names given to congenital tumors, consisting of a protrusion through a suture, or part of the skull which in fœtal life is membranous, of portions of the cranial contents. The *meningocele* contains merely a bag of cerebral membranes with sub-arachnoid fluid, while the *encephalocele* contains a portion of brain-substance as well. *Hydrencephalocele*, as the term is used by Prescott Hewett, is an encephalocele complicated by the protrusion of one of the ventricles filled with fluid. These malformations usually, but not invariably, occupy the occipital region, protruding a little behind the situation of the foramen magnum; they are usually solitary, but occasionally multiple, varying in size from that of a pea to that of the head itself, and complicated with internal hydrocephalus. The sac of a meningocele may be single or multilocular, and the contained fluid may be clear like that of a hydrocele, or may be dark from the admixture of blood. If the tumor be sessile, it may be wholly or partially reducible by pressure, such reduction being followed by symptoms of cerebral compression; the tumor swells up and becomes tense when the child cries, and sometimes partakes of the motions of the brain. The affection is occasionally complicated with nævus, and not unfrequently with other congenital malformations.

The *Diagnosis* from congenital cystic tumor, when the meningocele is sessile, is sometimes very difficult; but in most cases may be made by observing the situation of the malformation, its variations of tension, and the fact that it is not movable upon the skull; if, however, the communication with the cranial cavity be very small, the diagnosis may be quite impossible. The affection is also liable to be confounded with erectile tumors of the scalp, and, indeed, as already mentioned, the two diseases may coexist.

The *Prognosis* is unfavorable, the large majority of these cases terminating fatally during infancy, though occasionally patients thus affected have survived to adult life. Death is usually preceded by convulsions, due to cerebral pressure, but in some cases ulceration or rupture occurs, when inflammation of the sac and general spinal meningitis are the immediate precursors of the fatal issue.

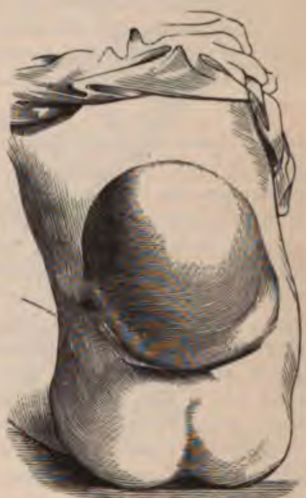
The *Treatment* in most cases should (according to Holmes, who has devoted special attention to the subject) be limited to affording support and making gentle *pressure*, by means of a gutta-percha cap lined with cotton wadding; and in cases evidently complicated with general hydrocephalus, nothing further is admissible; compression with a plate of sheet-lead proved successful in a case recorded by Dr. W. S. Hill, of Maine. If the tumor be rapidly increasing, without general symptoms, repeated *tappings* may be resorted to, with precautions against the entrance of air; the aspirator has been thus successfully employed by J. F. West. In cases of *meningocele*, if pedunculated, *iodine injections* may be tried with some hope of benefit. Finally, if there be reason to believe that, as sometimes happens, the communication with the cranial cavity has become obliterated, the tumor may be excised; or even if a communication persist, the operation might be occasionally justifiable, the pedicle of the tumor in such a case being first compressed by means of a clamp, which should be allowed to remain for twenty-four hours. A very remarkable case was reported a few years ago by Dr. Daniel Leasure, of Allegheny City, Pa., in which a meningocele (or, as the author termed it, hydrencephalocele) was said to have been radically and permanently cured by evacuating the contents of the sac, and invaginating its integuments, so as to plug the cranial aperture—very much as is done with the scrotal tissues in Wutzer's operation for the radical cure of hernia.

Paracentesis Capitis.—The operation of tapping the head is occasionally required in cases of acute, or even of chronic, hydrocephalus, when death seems imminent from the intra-cranial pressure exercised by the accumulated fluid. The relief afforded by paracentesis, under these circumstances, can scarcely be expected to be permanent, particularly in congenital cases, in which there is usually malformation of the brain. Still the operation is not, even in these instances, likely to add much to the gravity of the situation, while in the non-congenital cases it has unquestionably been occasionally productive of much benefit. An aspirating tube or very delicate trocar is to be employed, being introduced through the anterior fontanelle, as far as possible from the median line (so as to avoid wounding the longitudinal sinus), or, in cases of internal hydrocephalus, through the coronal suture on either side, midway between the anterior and sphenoid fontanelles, the point being then directed inwards and backwards so as to penetrate the lateral ventricle. A small quantity only (about two fluidounces) of fluid should be evacuated, the sides of the skull being compressed during the operation by the hands of an assistant. As soon as the instrument has been withdrawn, the puncture should be closed with an adhesive strip, and an elastic, perforated, India-rubber cap (as advised by Holmes) tightly drawn over the head, so as to support the skull and prevent syncope. If no bad results follow the operation, it may be repeated at another point, after a few weeks' interval. Injections of iodine have been practised in these cases, and in some instances with alleged benefit, but the only case in which I have seen this mode of treatment tried terminated fatally in less than forty-eight hours.

DISEASES OF THE SPINE.

Spina Bifida (*Hydrorachis*).—This is a congenital malformation, which consists in a deficiency of the spinous processes and laminæ of one or more vertebræ, allowing the protrusion of the spinal membranes, which form a tumor containing cerebro-spinal fluid and usually some of the spinal nerves, or even it is said a part of the spinal cord itself. Spina bifida in the *cervico-dorsal* region, however, according to Giraldès, contains no nervous filaments, and I was told by Dr. J. B. S. Jackson, of Boston, that in numerous dissections of spinæ bifidæ, he had invariably found the cord itself to terminate above the upper margin of the tumor. Hydrorachis may occupy any portion of the vertebral column, though most frequent in the lumbar and sacral regions; may be single or multiple; is usually of an oval shape; and varies in size from that of a walnut to that of a child's head. It may be sessile or pedunculated, sometimes lobulated, and is usually covered by skin of a more or less normal character, though in some instances there is no cutaneous investment, the sac-wall being constituted of the spinal dura mater itself, in which case ulceration is apt to occur. The tumor is tense and elastic when the child is in the upright position and during the action of *expiration*, becoming softer during *inspiration* and when the child is laid on its face. Fluctuation is sometimes observed, and partial reduction may be often effected by pressure—the bony aperture through which the protrusion has taken place being then perceptible to the touch. Spina bifida often coexists with other deformities, and is frequently complicated with hydrocephalus. Death usually occurs within a short time of birth, from convulsions or spinal meningitis, though occasionally life is prolonged to adult age (74 years in a case observed by Callender), and in some rare instances it would appear that a spontaneous cure has been effected by the channel of communication with the cavity of the spinal membranes becoming obliterated.

FIG. 333.



Spina bifida. (DRUITT.)

The *treatment* of this affection is usually not very satisfactory; if the tumor be not rapidly increasing in size, the surgeon should content himself with applying equable *support*, with perhaps slight *pressure*, by means of a well-padded leather or gutta-percha cap, or an air pad; if the skin be not irritable, the tumor may be painted with collodion, thus taking advantage of the contractile properties of that substance. If the child be otherwise healthy, and life seem to be endangered by the rapid growth of the tumor (threatening ulceration and rupture, or inducing convulsions or paralysis), *paracentesis* may be tried; the sac is tapped with an aspirator or a small trocar at a distance from the median line (in which position the nerve-structures are most likely to be placed), an ounce or two of fluid being evacuated, and the wound then instantly closed, and pressure reapplied. If these means fail, and the tumor be *pedunculated*, a small quantity of a solution of *iodine* may be cautiously injected, a plan which, with various modifications, has been successfully employed by Brainard, of Chicago, Velpeau, J. Morton, Watt, Eate, Ewart, and other surgeons. According to Morton, however, the iodine treatment is not applicable in cases accompanied by paralysis. The formula recommended by this surgeon is iodine, 10 grains; iodide of potassium, 30 grains; glycerine, 1 fluidounce. Of 18 cases treated in this way, 15 are said to have terminated successfully. *Ligation* and *excision* have been occasionally resorted to, and each has proved successful in at least one instance, but, in most cases, has but served to hasten death. The use of the *elastic ligature*, with or without paracentesis, has been employed by Laroyenne, Ball, Colognese, Baldossare, and Mouchet, 6 cases collected by the last-named surgeon having given 3 recoveries and 3 deaths. It is best adapted to cases in the cervical and dorsal regions, as in these no nerve-elements are involved.

False Spina Bifida.—Under this name are included three distinct conditions, viz.: (1) a true spina bifida, the connection of which with the spinal membranes has become obliterated; (2) a congenital tumor, cystic or fatty, which originates within the spinal canal and protrudes through an aperture due to a deficiency in the vertebral laminæ; and (3) a tumor containing fœtal remains, constituting the malformation properly described as included fœtation. If the surgeon can satisfy himself by careful and repeated examination, that, in a case of this kind, there is really no communication with either the cavity of the spinal meninges, or with the pelvic or other internal viscera, an operation for the relief of the deformity may be properly resorted to; if the tumor be evidently cystic, *iodine injection* would be the proper remedy, but under other circumstances *excision* would be preferable.[1]

Congenital Cystic Tumors, unconnected with the spine, but occupying the median line of the back, may closely simulate cases of spina bifida, but as pointed out by T. Smith, can sometimes be distinguished by feeling the line of spinous processes beneath the cyst; the diagnosis might further be aided by an analysis of the contained fluid, which in some cases of spina bifida has been found to contain a substance resembling grape-sugar.

Antero-posterior Curvature of the Spine (*Disease of the Spine, Pott's Disease*).—This affection usually originates in *osteitis* of the bodies of the vertebræ, though occasionally it would appear that the disease began in the intervertebral fibro-cartilages. In some instances—and in these the prognosis is least unfavorable—the case is one of ordinary osteitis; but in most cases there is evidence of the existence of scrofula, or even of the deposit of tubercle. Spine disease occurs chiefly in children and in young adults, and is perhaps rather more frequent in boys than in girls. Occasionally a fall or a blow is referred to as the exciting cause of the affection, but in most instances no explanation of its origin can be given. Any part of the vertebral column may be the seat of the disease, which is, however, most common in the dorsal region. The bodies of several vertebræ are usually simultaneously affected, becoming softened and disintegrated, and leading to disorganization of the intervertebral fibro-cartilages—the superincumbent weight of the head and upper part of the body eventually giving rise to the posterior angular deformity which is characteristic of the fully developed affection. In most cases the osseous change runs on to caries (whence the disease is frequently spoken of as *caries of the vertebræ*), abscess forming as a consequence, and the pus usually making its way to the surface, either in the loin or by descending in the course of the psoas muscle; in other cases, however, the pus, for a time at least, becomes concrete and obsolete, rendering the spine a favorite situation of the *residual abscess* (see p. 393). In a few instances the disease runs its course without any evidence of pus-formation whatever, the pathological change in these cases, therefore, being more properly designated as *interstitial absorption* than as caries (see p. 584).

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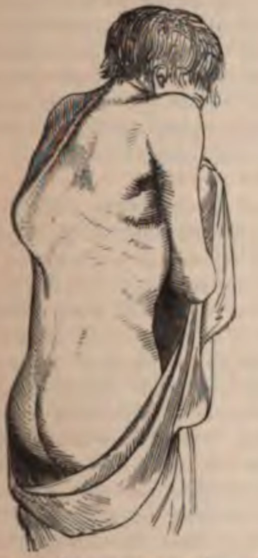
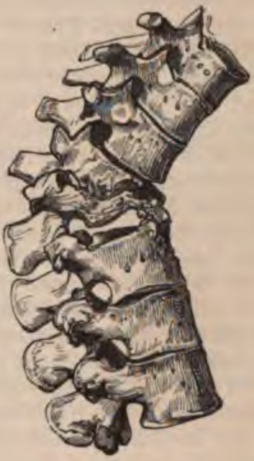
[1] See, upon this subject, Holmes's *Surgical Treatment of Children's Diseases*, pp. 90–93.

FIG. 334.



Antero-posterior curvature ot spine. (LISTON.)

FIG. 335.



Caries of the vertebra. (LISTON.)

Although, in the course of the disease, the spinal canal may be bent to a right angle, it is very seldom that the spinal cord is pressed upon or otherwise injured. This is evidently owing to the gradual nature of the change, which allows the cord to accommodate itself to its altered circumstances; and to the occurrence of anchylosis, which prevents injurious motion. *Anchylosis* is indeed the process by which nature effects a cure in these cases. It frequently goes on *pari passu* with the disintegrating changes, arches of new bone being thrown across from one vertebra to another, and the same specimen exhibiting at once caries, medullization, and eburnation in different parts. In cases in which anchylosis is deficient (as may happen when the angular projection is not marked, the diseased vertebral bodies being then separated and prevented from coalescing), spinal meningitis may occur, leading to secondary changes in the cord, and to consequent paralysis; while in the cervical region, where the vertebral column has a considerable range of motion, consecutive fracture or dislocation may take place, and, by compressing or bruising the cord, lead to a rapidly fatal issue.

Symptoms.—The early symptoms of spine-disease, particularly in children are somewhat equivocal, consisting chiefly in evidences of *spinal irritation*, such as weakness, numbness, and tingling of the lower extremities, a difficulty in standing or walking, with a tottering gait, and a tendency to fall forwards. The spinal column is somewhat *stiffened*, the patient moving it as a whole, and thus being unable readily to raise or turn himself in bed without assistance. Examination may reveal an undue *prominence* of some of the dorsal spines, with perhaps thickening of the surrounding tissues, and *tenderness* on pressure. *Pain* may be elicited by pressing on the head, or by making the patient jump from a stool to the floor, thus approximating the extremities of the vertebral column. In adults, pain is a more constant symptom, being usually of a dull, rheumatic character. *Spasmodic pain in the abdomen* is, according to Dr. B. Lee, an early and characteristic symptom of this affection. As the disease advances, *paralysis* may be developed, involving the lower or upper extremities, according to the part of the spine affected. Incontinence of feces and retention of urine sometimes form further disagreeable complications. *Abscess* sometimes occurs quite early in the course of the disease, and not unfrequently before the development of angular deformity. According to Dr. C. S. Bull, Pott's disease is usually accompanied with dilatation of the pupils, and with passive engorgement of the vessels of the retina and optic disk.

Diagnosis.—The diagnosis in the early stages is often very difficult; indeed it is sometimes quite impossible to distinguish spine-disease, particularly in children, from *inflammation of the surrounding ligamentous structures*, until the milder course of the latter affection reveals its true nature. From *neuralgia of the spine*, an affection analogous to the hysterical knee-joint, the diagnosis may be made by observing the absence, in the neuralgic affection, of rigidity or other physical evidence of disease, even in cases of long duration. The wincing of the patient, upon the application of a sponge wrung out of hot water to the suspected part of the spine, is looked upon by many surgeons as a sure proof of the existence of caries. According to my experience, this test is not to be implicitly relied upon; at least, I have known it to fail in cases in which the deformity and other symptoms left no doubt as to the nature of the case. The diagnosis from *morbus coxarius*, and from *sacro-iliac disease*, has already been referred to. (See pp. 605 and 608.) When the characteristic deformity appears, there is little difficulty in recognizing the nature of the affection. This deformity consists, as already mentioned, in a *posterior angular projection* of the diseased vertebræ, due to the absorption or disappearance of their bodies, and the consequent subsidence of the upper portion of the column. It is distinguished from the antero-posterior curvature of simple debility, by its persistence in the prone position—and from that of rickets, by its *angular* character. This angular deformity is accompanied, after the occurrence of anchylosis, with compensatory *forward curvatures* above and below; the gibbosity of the spine is thus thrown into a plane behind that of the pelvis, while the head is directed upwards and backwards, giving the peculiar but involuntary strut and air of pride which are so often seen in hunchbacks. Occasionally the displacement is at first somewhat lateral, and a hasty examination might then give the impression that the case was one of *lateral curvature;* the diagnosis may be made by observing that in true spine-disease there is no axial rotation of the vertebræ, such as always exists in the other affection (see p. 644). When the vertebræ involved are those of the cervical region, particularly the atlas and axis, the case may be mistaken for one of *wry-neck.* The sterno-mastoid muscles are, under these circumstances, tense and prominent, and the neck stiff; while the patient often involuntarily supports the head with both hands, so as to guard against sudden movements. The diagnosis from wry-neck may be made by noting the localized tenderness and thickening of the spine, and the increase of pain by tapping or pressing on the head.

The diagnosis of *Abscess arising from Spine-disease* requires some attention. The situation of the abscess, in these cases, varies with the part of the vertebral column which is involved. Thus, in disease of the *cervical* vertebræ, the pus may present itself at the back of the pharynx, at the side of the neck (beneath the sterno-mastoid muscle), or more rarely in the axilla; it may even pass downwards into the thoracic cavity. Abscess from disease of the *upper dorsal* vertebræ commonly makes its way downwards, along the course of the aorta and iliac arteries, presenting itself in the iliac fossa *above* Poupart's ligament, but may gravitate to the back of the pelvis, passing out through the sacro-sciatic notch into the gluteal region, may pass forwards along the ribs, opening at the side of the trunk, or may go directly backwards, forming a dorsal or lumbar abscess; finally, it may, in some rare cases, burst into the air-passages or gullet. When the *lumbar* and *lower dorsal* vertebræ are affected (the most common situation of the disease), the abscess usually descends in the sheath of the psoas muscle, on one or both sides, constituting the condition known as *psoas abscess*.[1] This generally points in the front of the thigh *beneath* Poupart's ligament, but may burrow downwards to the ham or even to the ankle. In other cases the pus may present itself in the lumbar region, in the perineum, on the outer side of the hip, in the iliac fossa, or in the inguinal canal; or it may even burst into the bowel or bladder. By care and attention it is usually possible to determine whether an abscess, occurring in any of these situations, be or be not dependent upon disease of the spine. It is, however, sometimes a matter of great difficulty to distinguish between *psoas* and *iliac abscess*—the former commonly arising, as we have seen, from caries of the dorsal or lumbar vertebræ, while the latter originates in the areolar tissue of the iliac fossa, and may or may not be connected with disease of the bony pelvis. This difficulty is further increased by the circumstance that, while spinal abscess occasionally presents itself, as we have seen, in the iliac region, an iliac abscess may, on the other hand, make its way into the sheath of the psoas muscle. *Psoas abscess* is, however, commonly a disease of early life, points *below* Poupart's ligament, is usually attended with irritation and rigidity of the psoas muscle, and often makes its appearance suddenly; while *iliac abscess*, on the other hand, occurs almost exclusively in adults, points *above* Poupart's ligament, and is gradually developed.

Psoas and iliac abscesses must also be distinguished from *inguinal aneurism* which has become suddenly diffused, from *femoral hernia*, and from *fatty*, *serous*, or *hydatid tumors*. The diagnosis from *aneurism* may be made by investigating the *history* of the case, and by observing the presence of fluctuation and the absence of any *bruit* or other stethoscopic signs. From *hernia*, the affection may be distinguished by noting the fluctuating character of the swelling, the absence of gurgling (in both diseases the swelling is reducible, and there may be an impulse transmitted by coughing), and the situation of the femoral vessels, which in hernia are to the *outside*, and in abscess usually to the *inside*, of the tumor. *Fatty and other tumors* may be recognized by their not being reducible within the abdomen, and, if necessary, by the use of the exploring needle.

Prognosis.—The prognosis of antero-posterior curvature of the spine is never favorable; the best that can be hoped for is the occurrence of anchylosis, with a permanent angular deformity. If the spine retain its straight position, fatal inflammation of the membranes is apt to occur, while if abscess forms, the patient almost always perishes from exhaustion or from secondary visceral disease. In a case at the Episcopal Hospital, some years ago, a psoas abscess caused ulceration of a branch of the internal iliac artery, leading to rapid death from hemorrhage.

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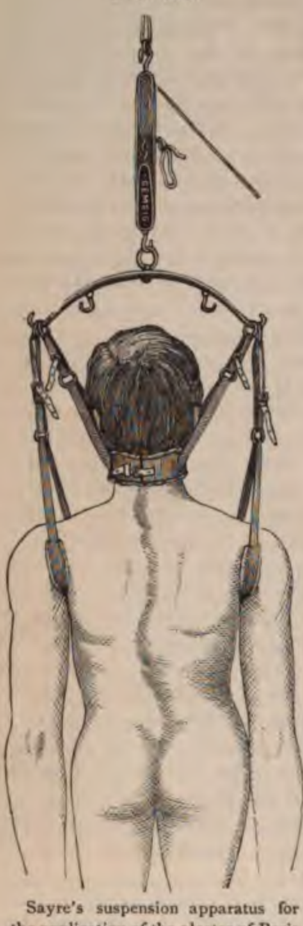
[1] Psoas abscess, however, according to Stanley, Bryant, and others, sometimes originates independently of spinal disease.

FIG. 336.



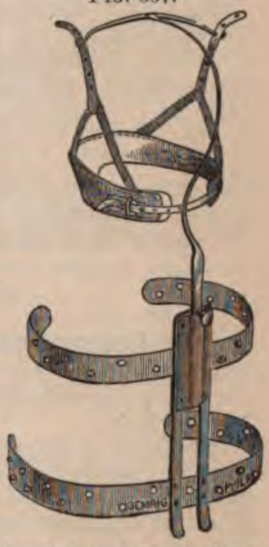
Sayre's suspension apparatus for the application of the plaster-of-Paris bandage.

Treatment.—In the treatment of disease of the spine, *rest of the part* is of the utmost importance: if the cervical vertebræ be affected, the head must be carefully supported with sand-bags or other mechanical contrivance, so as to prevent any sudden movement which might cause death by producing dislocation. In ordinary cases, the patient may be confined to the *horizontal position* on a suitable couch, the prone being more desirable than the supine posture. No attempt should as a rule be made either to extend the spine or to remove any existing backward projection, for such attempts are liable to do harm by interfering with the occurrence of anchylosis; if, however, the part were very painful, it might be proper to give a cautious trial to continuous *double extension*, as recommended by J. Wood. The horizontal position must be rigidly maintained for many months, until the surgeon can satisfy himself indeed that bony union of the diseased vertebræ is well advanced. *Tonics*, especially cod-liver oil, may be exhibited with advantage, and the patient, if a child, should be daily carried into the *open air* on a couch or in a suitable coach.

Counter-irritation (by means of setons, issues, or the actual cautery) was highly commended by Pott, who first accurately investigated the nature of this disease—and is still in much repute with many surgeons. I am not myself very enthusiastic with regard to these severe applications, believing with Shaw and Holmes that, in most cases, the milder remedy of painting the tincture of iodine on either side of the affected vertebræ will be quite sufficient. If there be much pain, tenderness, and other evidence of inflammation, there can be no better local remedy than *dry cold* applied in the form of an ice-bag.

In most cases, it will be desirable to combine *mechanical support* with rest in the prone position, and this may be conveniently done by the use of a moulded gutta-percha, leather, felt, or pasteboard splint, or a corset-like bandage stiffened with whalebones, or a plaster-of-Paris bandage, applied while the patient is partially suspended by the head and shoulders, as recommended by Prof. Sayre, or lying prone in a canvas hammock (which is itself included by the bandage), as advised by R. Davy. Mr. Adams, and J. C. Hutchison, of Brooklyn, apply a "poro-plastic felt" jacket, while the patient is suspended, and consider this material, upon the whole, better than the plaster-of-Paris. Dr. Stillman and Dr. Wyeth, of New York, employ a double plaster jacket, with extending bars secured to perforated zinc plates placed between the layers of plaster. Dr. Vance, of the same city, employs a brace made of glue and paper. When anchylosis is well advanced, the patient may be allowed to get up, wearing the leather, felt, or plaster jacket, or a well-fitting apparatus consisting of a firm pelvic band with crutch-pieces to take off the weight of the upper portion of the trunk, and suitable pads and straps to immovably fix the portions of the spine above and below the seat of deformity. If the cervical vertebræ be involved, a firm but well-fitting leather collar, so arranged as to fix the neck and support the head and chin, may be employed, or an occipito-mental sling, suspended from Sayre's "jury mast" (Fig. 337), attached to the plaster or leather jacket, or to the ordinary "spinal apparatus," as may be preferred. In some cases, Steele, of Bristol, adapts the jury mast and axillary supports to the chair which the patient ordinarily uses, and finds this more convenient than any other form of apparatus.

FIG. 337.



Sayre's "jury mast" for disease of the cervical vertebræ.

The *treatment of spinal abscess* is that of cold or chronic abscess in general (see page 393). Every effort should be made, in the first place, to induce absorption of the fluid, it being remembered that, even if a residual abscess follows at a later period, the prognosis will then, probably, be more favorable than if the collection had been evacuated in the first instance. Even if the opening of a psoas abscess appear inevitable, it is better in most instances to leave the case to nature, rapid sinking not unfrequently following the use of the knife under these circumstances. If, however, it be determined to interfere, the aspirator may be used, or a valvular incision may be made, or the abscess cavity may be washed out with a solution of carbolic acid, or, finally, the surgeon may adopt the precautions recommended by Prof. Lister. Dr. S. W. Gross advises that after the abscess has been evacuated, its walls should be supported with adhesive strips and a flat sponge, and that opium should be freely administered. Fischer and Riedel have evacuated psoas and pelvic abscesses by trephining the ilium.

Arthritis occasionally attacks the articulations of the vertebræ, and, in the case of the occipito-atloid and atlo-axoid joints, is attended with risk of sudden death from the occurrence of dislocation. The most important points in the *treatment* are to fix the head and neck by suitable mechanical appliances, so as to prevent injurious movements, and to give free vent to any pus that may be formed, lest suffocation should result from pressure of the abscess upon, or its bursting into, the air-passages.

Necrosis of the bodies of the cervical vertebræ is occasionally seen in cases of syphilitic ulceration, or as the result of gunshot or other injuries; and cases in which recovery has followed the discharge of large sequestra, under these circumstances, have been recorded by Wade, Keate, Syme, Mercogliano, Morehouse, Bayard, Mackenzie, Ogle, Beck, and Chatman.

Anchylosis of the spine, as a result of Pott's disease, has already been referred to; it may also occur as a consequence of rheumatoid arthritis, as described by R. W. Smith, Von Studen, and Sturge, the latter of whom proposes for the affection the name of *spondylitis deformans.*

CHAPTER XXXV.

DISEASES OF THE EYE.

It would be utterly impossible to give, within the narrow limits of this chapter, even a sketch of the present state of ophthalmic surgery, nor indeed would the attempt to do so be worth making, since the diseases of the eye have become, of late years, to a great degree, an object of especial study, and since numerous excellent manuals and treatises on the subject are accessible to any one who may desire to make himself familiar therewith. I shall, therefore, chiefly confine my attention, in the following pages, to a brief reference to those more common affections of the eye which every surgeon may be called upon to treat, and to a short description of the more important operations which are performed upon this organ.

Diseases of the Conjunctiva.

Acute Conjunctivitis (*Catarrhal Ophthalmia*).—An inflammation of the conjunctiva, usually caused by cold or other local irritation, but sometimes prevailing epidemically in certain localities, and apparently transmissible by contagion.

Symptoms.—A sensation as of dust in the eye, with heat, smarting, and stiffness of the lids. The conjunctiva is brilliantly injected, the redness being quite superficial, and, at first, greatest at the circumference of the globe. Slight photophobia, with increased lachrymation, followed by muco-purulent discharge, which, becoming dry, causes the lids to adhere.

Treatment.—Astringent lotions of alum, sulphate of zinc, or corrosive sublimate (gr. ⅛ to f℥j), with frequent *ablutions with cold water,*[1] and, in severe cases, the application once or twice daily of a few drops of a solution of *nitrate of silver* (gr. j–ij to f℥j). The lids may be smeared at night with simple ointment, to prevent their adhering together. The constitutional treatment consists in regulating the digestive functions, and in improving the general health by the use of *tonics,* especially iron and quinia. A shade may be worn if there is much photophobia.

Chronic Conjunctivitis, or *Chronic Ophthalmia,* may occur as a sequel of the affection just described, or may originate from the irritation of inverted lashes, or from reading or sewing with an insufficient light.

Treatment.—The cause must, if possible, be removed, by taking away any sources of local irritation, forbidding overuse of the eyes, etc. In addition to the measures above directed for the acute form of the affection, *counter-irritation* by means of a small blister or the vapor of bromine may be advantageously applied to the temples, or behind the ears. If complicated with granular lids, this condition must, of course, be remedied before the conjunctival inflammation can be cured.

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[1] L. Connor, however, advises douches of *hot* water in all inflammatory affections of the eyes.

Phlyctenular Conjunctivitis (*Pustular or Papular Ophthalmia.*—This is a form of conjunctivitis characterized by the formation of little elevated vesicles, with increased vascularity of the conjunctiva in their immediate vicinity. The treatment, after any acute irritation has been subdued, consists in dusting into the eye with a camel's-hair brush a little finely powdered calomel, in the application to the inside of the lids of a weak red precipitate ointment (gr. iv–viij to ℥j), or in dropping into the eye, thrice daily, a weak solution of the bichloride of mercury.[1]

Purulent Conjunctivitis, or *Purulent Ophthalmia*, is a very high grade of conjunctival inflammation, attended with a profuse muco-purulent discharge which is fully developed within twenty-four to forty-eight hours after the first onset of the disease. There are three varieties, the purulent ophthalmia of new-born infants, the contagious or Egyptian ophthalmia of adults, and the gonorrhœal ophthalmia, which has already been considered. (See page 439.)

Ophthalmia Neonatorum.—This form of the disease usually begins a few days after birth, involving both eyes simultaneously or consecutively, and sometimes ending in total loss of vision. The affection often appears to originate during birth, from direct contact with a purulent vaginal discharge in the mother.

Symptoms.—A whitish or yellow, muco-purulent or purulent discharge, rapidly increasing in quantity, with swelling of the lids and chemosis of the ocular conjunctiva. If the disease be not checked, opacity, ulceration, or even sloughing of the cornea will probably occur, with, of course, total loss of sight.

Treatment.—The discharge should be removed as fast as it accumulates, by syringing the eye with a solution of alum (gr. v to f℥j), to which Power advises that permanganate of potassium should be added, every half hour, day and night, the lids being gently separated with the thumb and finger of the left hand, while the syringe is worked with the right; or, the lids being everted, a five-grain solution of nitrate of silver may be applied, with a camel's-hair brush, once a day, any excess of the caustic being immediately neutralized with a solution of common salt; the lids should be greased with simple ointment, to prevent their sticking together. Dor advises the application of solutions of tannin and benzoate of sodium, and Wolfe those of borax followed by atropia, and, in bad cases, cauterization with the *lapis mitigatus*. (See page 667.) Diluted chlorine water is employed by Moore, of New York. If ulceration of the cornea occur, quinia should be given in doses of about half a grain, three times a day. As a *prophylactic* measure, Credé advises that the eyes of children exposed to the disease should be covered with a bandage wet with a solution of salicylic acid, and Olshausen recommends the application of carbolic acid, beginning his treatment even before the child has been completely born.

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[1] The following formula, which corresponds to the preparation known as *Aqua Conradi*, will be found satisfactory: ℞. Hydrarg. chlorid. corrosiv. gr. ¼; Mucilag. cydonii fʒss; Vin. opii gtt. v; Aquæ destillat. f℥ij. M.

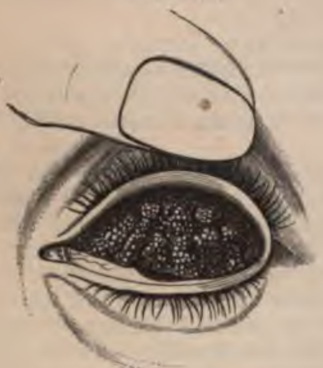
Purulent Ophthalmia of Adults, *Contagious or Egyptian Ophthalmia* (so called from its prevalence as an endemic in Egypt), in its mildest form resembles catarrhal ophthalmia, but often runs a course quite as severe as the affection which results from the contagion of gonorrhœa. Purulent ophthalmia is eminently contagious, and often prevails as an epidemic. It may originate sporadically from various forms of local irritation.

Symptoms.—A muco-purulent and afterwards purulent discharge, with great chemosis, and inflammation and swelling of the lids, with burning pain, and a good deal of constitutional disturbance. One or both eyes may be attacked. Opacity, ulceration, or sloughing of the cornea may ensue, or the inflammation may spread to the deeper tissues of the eye; or a persistent granular condition of the lids may be developed.

Treatment.—If only one eye be affected, the other should be effectually closed by means of Buller's bandage (page 440), or a compress of charpie covered with a disk of adhesive plaster, and the whole coated with collodion. This may be removed twice a day, to wash and inspect the organ. In mild cases, astringent and detergent applications, as recommended for catarrhal ophthalmia, will probably prove sufficient; but, if the disease assume a severe type, no time should be lost in adopting those measures which were fully detailed in speaking of *Ophthalmic Gonorrhœa.* (See page 439.) The application of copaiba to the lower eyelids, cheeks, and temples, is recommended by A. R. Hall. Planat and Dabney speak well of the topical use of ergot.

Diphtheritic Conjunctivitis is an affection rarely met with in this country, but which has been recently well described by Dr. Robert Sattler, of New York. The *treatment* in the early stages consists in the application of iced compresses, with frequent syringing with lukewarm salt and water, and at a later period in the cautious use of nitrate of silver. Bergmeister recommends the insufflation of the flowers of sulphur.

FIG. 338.



Granular lids. (JONES.)

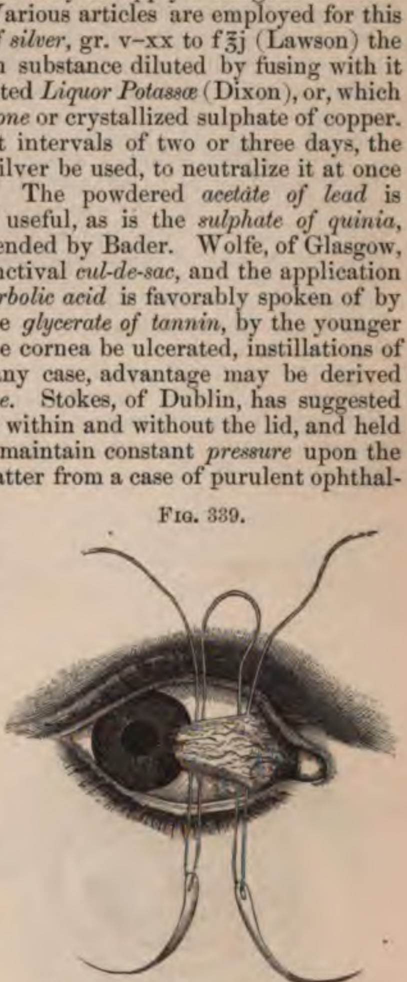
Tuberculous Ulceration of the conjunctiva, the cornea being unaffected, is a rare affection described by Sattler as occurring in the latter stages of general tuberculosis.

Granular Lids (*Trachoma*) is a condition which has been referred to in the preceding pages, and which consists of a rough, villous, granular state of the palpebral conjunctiva, keeping up a chronic muco-purulent discharge, causing much pain, and inducing, by friction, a vascular and hazy condition of the cornea. There are two conditions to which the name of granular lids is commonly applied, one consisting merely in a hypertrophied state of the papillæ, and the other in the development of *true* or *vesicular granulations,* which are by some authors regarded as new formations, the result of inflammatory action, and by others as enlargements of the closed lymphatic follicles. These vesicular granulations appear as little round bodies, like the grains of boiled sago, often occur epidemically, and are transmissible by contagion.

Symptoms.—Heat and a sensation as of sand in the eye, with slight photophobia, and enough discharge of muco-pus to glue together the eyelids during the night. The caruncle and tarsal margins of the lids are reddened, and the upper lid is thickened and droops over the eye. The cornea becomes nebulous, uneven, and extremely vascular (*Trachomatous Pannus*), and ulceration sometimes occurs. The palpebral conjunctiva may eventually undergo contraction, causing *Entropion* and *Distichiasis.*

Treatment.—In some cases, *counter-irritation* to the *outside* of the lids, as by the application of the tincture of iodine, with the use of *tonics*, will be sufficient. In other cases it may be necessary to apply astringents or caustics to the granulations themselves. Various articles are employed for this purpose, such as a solution of *nitrate of silver*, gr. v–xx to f℥j (Lawson) the "*lapis mitigatus*," or nitrate of silver in substance diluted by fusing with it nitrate of potassium (Wells), the undiluted *Liquor Potassæ* (Dixon), or, which is a favorite in this country, the *blue-stone* or crystallized sulphate of copper. These applications may be repeated at intervals of two or three days, the precaution being taken, if nitrate of silver be used, to neutralize it at once by the injection of salt and water. The powdered *acetāte of lead* is another remedy which is occasionally useful, as is the *sulphate of quinia*, dusted into the eye in the way recommended by Bader. Wolfe, of Glasgow, recommends scarification of the conjunctival *cul-de-sac*, and the application of the syrup of tannin (ʒij–f℥j). *Carbolic acid* is favorably spoken of by Chisolm, as are *chlorine water* and the *glycerate of tannin*, by the younger Sichel, and *iodoform*, by Hayer. If the cornea be ulcerated, instillations of *atropia* should be practised, and, in any case, advantage may be derived from the use of a *compressing bandage.* Stokes, of Dublin, has suggested the use of delicate ivory plates, applied within and without the lid, and held together by a spring or screw, so as to maintain constant *pressure* upon the granulations. *Inoculation*, with the matter from a case of purulent ophthalmia, has been successfully employed in inveterate cases by Bader, Dixon, Lawson, and others. *Syndectomy* or *Peritomy*, which is an operation consisting in the excision of a very narrow band of conjunctiva and subconjunctival tissue from around the cornea, may be practised in cases of *pannus* which persist after the relief of granular lids. This operation, which was introduced by Furnari in 1862, is also recommended by Lawson, as a preliminary to purulent inoculation. *Canthoplasty*, or slitting up the outer canthus, and stitching together the skin and mucous membrane above and below so as to prevent readhesion, is recommended in these cases by Althof, Noyes, C. R. Agnew, and others.

FIG. 339.



Pterygium. (STELLWAG VON CARION.)

Pterygium.—This is a peculiar, fleshy growth, consisting of a hypertrophy of the conjunctiva and subconjunctival tissue, which is most common in warm climates. One or both eyes may be affected, the growth almost invariably occupying the inner or nasal part of the eye, arising by a fan-shaped expansion from the semilunar fold and lachrymal caruncle, and converging as it approaches the cornea, the centre of which it rarely passes. The *treatment* consists in *excision*, which is performed by seizing the pterygium with toothed forceps, raising it from the surface of the eye, and shaving it off from its corneal attachment, then turning it backwards and carefully dissecting it from its base; the growth is apt to recur, to prevent which the seat of attachment may be touched every two or three days with a crystal of blue-stone. Another operation, called *transplantation,* consists in dividing the corneal attachment, turning the pterygium back, and fixing its free extremity in an incision in the lower part of the conjunctiva, by means of a fine suture; or the growth may be removed by means of a *ligature* threaded upon two needles, and introduced as seen in Fig. 339. When the needles are cut off, the pterygium is transfixed by three ligatures, by the tightening of which it is effectually strangulated. According to Dr. Dabney, the growth of a pterygium may be checked by the local use of ergot.

Lupus of the Conjunctiva is usually secondary to a similar condition of the neighboring skin, but, according to Sattler, may occur as a primary affection. The *treatment* consists in repeated cauterization with the solid nitrate of silver, and the application of the ointment of the yellow oxide of mercury, suitable constitutional remedies being at the same time administered, as in cases of lupus occurring in other parts.

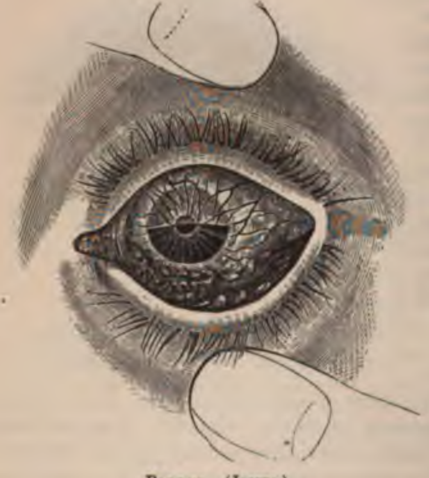
Psoriasis and **Pityriasis** of the conjunctiva are described by Terrier and Blazy respectively.

Tumors of various kinds grow from the conjunctiva, and may be readily excised with toothed forceps and delicate scissors, curved upon the flat. For serous cysts occurring in this region, it is sufficient to cut away the anterior wall of the cyst, and then touch the part with a pointed stick of nitrate of silver.

DISEASES OF CORNEA, SCLEROTIC, AND CILIARY BODY.

Keratitis (*Corneitis, Inflammation of the Cornea*).—Essentially a disease of malnutrition, most common in children, sometimes arising from injury, but often from no obvious cause. Both eyes are usually consecutively affected, the course of the disease extending from six months to two years. The *symptoms* are pinkness (not the redness of conjunctivitis) in the ciliary region (see page 675), with haziness of the cornea, dimness of vision, photophobia, lachrymation, pain, and a sensation of dust in the eye, with (in the stage of repair) a red appearance of the cornea due to its increased vascularity, the resulting condition of *Pannus* sometimes involving almost the whole cornea. In favorable cases this increased vascularity gradually fades away, and the part resumes its normal appearance, but in other cases corneal ulcers are developed and retard recovery. Permanent though slight dimness of vision generally remains, due to a general haziness of the cornea, or to the formation of a *Nebula* in the pupillary region.

FIG. 340.



Pannus. (JONES.)

Treatment.—*Internally*, attention to the digestive functions, with the administration of tonics, such as iron and quinia, and of opium or belladonna, if there be much pain and photophobia. *Locally*, the use of sedatives, particularly belladonna or atropia, with counter-irritation by means of iodine or the solid stick of nitrate of silver to the brow and upper lid, the eyes being protected from light by a shade or dark-colored glasses. Dr. Bull, of New York, recommends the use of iodoform, both internally and as a topical application. Oppenheimer employs instillations of iced water.

Chronic Interstitial Keratitis is a frequent manifestation of *hereditary syphilis* (see p. 463). Hutchinson recommends the cautious use of mercury, applied by inunction behind the ear. Attention to the digestive functions, and the administration of tonics, are also necessary. Bader recommends the use of croton chloral hydrate in doses of gr. v–x, three times a day.

Strumous Keratitis, in its course and symptoms, resembles the simple form of the affection already described; the photophobia and lachrymation are more marked, and corneal ulceration is apt to occur. The *treatment* consists in the administration of cod-liver oil and the syrup of the iodide of iron, and in improving the hygienic surroundings of the patient.

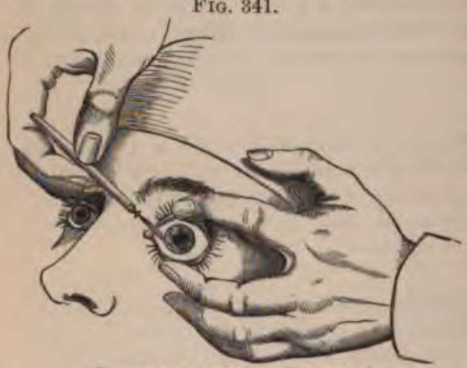
Phlyctenular Keratitis.—Closely allied with the preceding, is this affection, which is also known as *Phlyctenular or Scrofulous Ophthalmia*, and as *Herpes Corneæ;* it frequently accompanies *phlyctenular conjunctivitis* (p. 665). This disease, which occurs in quite young children, is attended with intense photophobia and spasms of the orbicularis palpebrarum (*blepharospasm*), which often renders the induction of anæsthesia necessary before a satisfactory examination can be made. The affection receives its name from the existence, usually near the corneal margin, of phlyctenular or herpetic vesicles, which burst, leaving superficial but slowly healing ulcers. The *treatment* is essentially that of keratitis in general; if, as often happens, there is eczema of the lids, advantage may be derived from the use of borax lotions. The administration of arsenic is recommended by Wells, in some cases, as is calomel insufflation, when the disease has become chronic. Power speaks favorably of the internal administration of belladonna. A solution of sulphate of eserine (gr. ij to f℥j) is recommended by H. W. Williams as a local application. The affection is apt to recur, and frequently produces permanent opacity or even perforation of the cornea. For the accompanying *blepharospasm*, C. R. Agnew and Cornwell recommend forcible separation of the eyelids, and exposure of the eye to the air.

Suppurative Keratitis.—This affection may be excited by traumatic causes, or may be secondary to other inflammatory diseases of the eye. Suppurative keratitis is, as its name implies, attended with the formation of pus between the layers of the cornea, in one part only, or throughout its structure. The resulting *Abscess of the Cornea* usually bursts exteriorly, leaving an unhealthy-looking ulcer; but occasionally opens into the anterior chamber of the eye, giving rise to the condition known as *Hypopyon*. A small abscess at the lower part of the cornea, from its fancied resemblance to the lunula of the thumb-nail, is called *Onyx*. The *treatment* consists in the use of tonics and anodynes, with good food and stimulants if necessary. Locally, *atropia* should be freely used, with a *compressing bandage*, or, in cases unattended with pain or intolerance of light (the non-inflammatory form of

Wells), *warm chamomile fomentations. Paracentesis of the cornea* may be performed once or oftener, serving to relieve intra-ocular tension, and to evacuate the pus if hypopyon be present. If the abscess be central, an *iridectomy* should be performed opposite a clear portion of the cornea.

Paracentesis Corneæ is performed by puncturing the cornea near its lower margin with a broad needle held flatwise, the point being kept well forward, so as to avoid wounding the lens; by rotating the needle slightly on its long axis, the opening is rendered patulous, allowing the slow escape of the aqueous humor and of any pus that may be present. The operation is completed by restoring the needle to its original position, and quickly withdrawing it. This little operation is usually facilitated by separating the lids with a stop speculum, and steadying the eye with suitable fixation forceps. Anæsthesia may be employed if desirable.

FIG. 341.



Paracentesis corneæ. (ERICHSEN.)

Ulcers of the Cornea.—These may result from various forms of conjunctivitis and keratitis, or may apparently originate primarily, as the result of depraved health and malnutrition. Several varieties of corneal ulcer are described by systematic writers, as the superficial and deep, the transparent and nebulous, the sloughing, and the crescentic or chiselled ulcer. These names sufficiently explain themselves. The deep and sloughing ulcers are apt to lead to perforation, previous to the occurrence of which, the membrane of Descemet, with, according to Stellwag, the posterior layer of the cornea, may bulge forwards through the site of the ulcer, forming a transparent vesicle which is called *Keratocele* or *Hernia of the Cornea.* During the stage of repair, in any case of corneal ulcer, enlarged vessels may be seen running from the margin to the ulcerated surface; should these vessels remain permanently after cicatrization, the condition usually known as *chronic vascular ulcer* results.

Treatment.—The treatment of ulcers of the cornea usually requires the administration of tonics and good food, with attention to the digestive functions. Locally, soothing applications are commonly indicated, such as lotions of *belladonna* or *poppy-heads*, the instillation of *atropia* or *eserine*, hypodermic injections of *morphia*, etc, Hayer recommends the employment of iodoform. It is only in chronic cases that *stimulating applications* are ever proper, and even in these they should be used with caution. *Syndectomy* (see page 667) has been occasionally employed with advantage in the treatment of the crescentic ulcer, which is a very intractable form of the affection. *Paracentesis corneæ* is often of use in cases of sloughing ulcer. This operation should be performed (through the floor of the ulcer) whenever perforation is threatened, a compressing bandage being subsequently applied. If the intra-ocular tension be very great, *iridectomy* may be preferable. During the stage of repair, the patient should be encouraged to take exercise in the open air, and, if the part fall into the condition of the chronic vascular ulcer, a compressing bandage and a seton in the temporal region will often prove of service.

Fistula of the Cornea may result from a wound, or from the imperfect healing of a perforating ulcer. The *treatment* consists in the application of a compressing bandage, in touching the edges of the fistulous orifice with nitrate of silver, or, if these fail, in the performance of an iridectomy. Sometimes the fistulous condition is maintained by the irritation caused by a wounded lens, which should then be removed. As a last resort, Lawson recommends paring the edges of the fistula, and bringing them together with a fine silk suture. The intentional formation of a corneal fistula is recommended (under the name of Keratectomy) in some cases of ophthalmitis, by Spencer Watson.

Opacities of the Cornea.—*Nebula* is the slightest form of opacity, consisting of a mere filmy cloudiness which may be superficial or interstitial, and which commonly results from keratitis or superficial ulceration. *Albugo* or *Leucoma* is a dense opacity, due to the cicatrization of a deep ulcer, as of a small-pox pustule.

Treatment.—Various remedies are employed for *nebula*, such as the insufflation of calomel, or the use of lotions containing corrosive sublimate, oil of turpentine, sulphate or chloride of zinc, iodide of potassium, sulphate of sodium, or common salt. A weak ointment of the red or yellow oxide of mercury is highly spoken of by Wells. *Leucoma*, which is usually incurable, may require the formation of an artificial pupil opposite a clear portion of the cornea. Opacity resulting from the injudicious application of preparations of *lead* to an ulcerated cornea, may be remedied by shaving off the deposit with a delicate knife, convex on its cutting edge: after the operation, the abraded surface should be protected by applying a drop of olive or castor oil, and by the use of cold water dressing. The same treatment may be required if *calcareous degeneration* occur in an ordinary leucoma. In order to obviate the deformity caused by opacities of the cornea, Wecker, C. B. Taylor, Levis, of this city, and others, recommend that the opaque spots should be *tinted* with various coloring matters, as in the familiar operation of *tattooing*. Power, Gradenigo, Schoeler, and others, go further, and having removed the opaque portion, transplant a segment of a rabbit's or dog's cornea to supply the deficiency. These operations have occasionally been followed by irido-cyclitis, and should not be resorted to, therefore, without due caution. Sellerbeck and Wolfe have successfully transplanted portions of the cornea from the extirpated eyes of other patients.

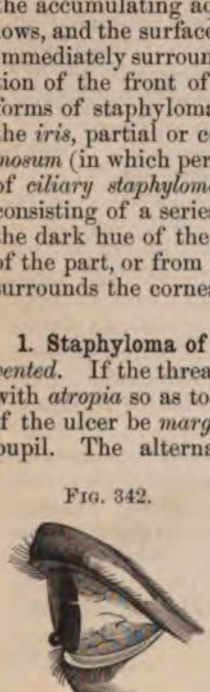
Conical Cornea.—The cornea retains its transparency, but assumes a conical form, the apex of the projection being commonly central. Vision is interfered with by the development of *myopia* (short-sightedness) and *astigmatism*, the latter being a general term for want of symmetry in the state of refraction of different meridians of the eye. In slight cases, vision may be aided by the use of concave glasses, with a diaphragm containing a circular or slit-shaped perforation, but in most instances an *iridodesis* should be performed, or, if there be much intraocular tension, a small upward *iridectomy*. Another plan, suggested by Von Graefe, is the formation of an ulcer on the apex of the protrusion, by cutting off a small superficial flap and subsequently cauterizing the surface. The contraction which accompanies the cicatrization of the ulcer diminishes the conicity of the cornea. Bader and Nunneley have modified Von Graefe's operation by cutting off the flap and bringing the edges of the wound together with delicate sutures. Chisolm punctures the cornea with a needle heated to redness.

Kerato-globus, Hydrophthalmia, or Buphthalmos, is an affection analogous to the preceding, consisting in a uniform, spherical bulging of the whole cornea. If the disease be rapidly increasing, a large *iridectomy* may be performed, while if vision be lost, and the protrusion prevent the closure of the eyelids, *excision* may be indicated.

Staphyloma.—When perforation follows an ulceration of the cornea, the iris commonly falls forwards. If the corneal aperture be very small, no protrusion may occur, the iris merely adhering to the inner corneal surface (*anterior synechia*); under other circumstances prolapse of the iris takes place, the protrusion increases by the distention produced by the pressure of the accumulating aqueous humor, adhesion to the margin of the ulcer follows, and the surface assumes a cicatricial character. The portion of cornea immediately surrounding the protrusion also yields, and a disfiguring projection of the front of the eye results, which is called *staphyloma*. Various forms of staphyloma are described by systematic writers as staphyloma of the *iris*, partial or complete staphyloma of the *cornea*, and staphyloma *racemosum* (in which perforation occurs at several points); again, surgeons speak of *ciliary staphyloma*, or *anterior*[1] *staphyloma of the sclerotic*—this condition consisting of a series of bulgings of the weakened sclerotic (through which the dark hue of the ciliary body is perceptible), and resulting from injury of the part, or from chronic irido-choroiditis. When the staphyloma entirely surrounds the cornea, it is said to be *annular*.

1. Staphyloma of the Iris.—Prolapse of the iris may sometimes be *prevented*. If the threatened perforation be *central*, the pupil should be dilated with *atropia* so as to keep the iris out of the way, while, on the other hand, if the ulcer be *marginal*, the *Calabar bean* should be used to contract the pupil. The alternate use of these substances may also prove useful in breaking up an *anterior synechia*. If prolapse of the iris have actually occurred, an attempt may be made to *replace* the protrusion with a delicate probe, aided by the instillation of atropia. If this fail, the prolapsed iris should be *punctured*, so as to let it collapse, a compressing bandage being then applied; or the prolapsed or staphylomatous iris may be punctured, and then *excised* close to the cornea with curved scissors, a compressing bandage being used as before. Finally, if the prolapse or staphyloma be extensive, a large *iridectomy* may be performed in an opposite direction, this operation diminishing the intraocular tension, and thus lessening or at least preventing the increase of the projection, while it also affords an artificial pupil if that should be required. Another plan of treating prolapsed iris consists in touching the protruding portion with a pointed stick of nitrate of silver, as recommended by Dixon.

FIG. 342.



Prolapse of the iris. (MILLER.)

2. Partial Staphyloma of the Cornea.—This may be considered as an aggravated degree of *Staphyloma of the Iris*. The *treatment* consists in the formation of an *artificial pupil*, opposite a healthy part of the cornea, by *iridectomy.*

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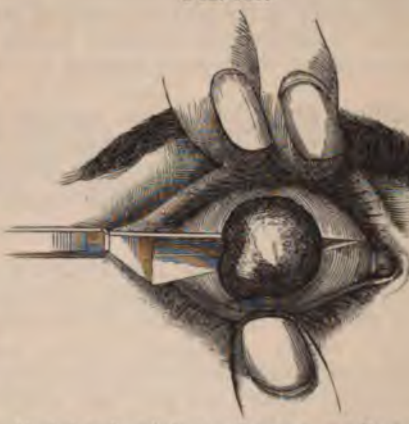
[1] *Posterior staphyloma* is a projection of the posterior half of the eye, met with in severe cases of myopia.

3. Complete Staphyloma of the Cornea signifies a staphylomatous condition of the entire corneal surface. Its occurrence may be sometimes *prevented* by an early *removal of the lens*, either immediately after the sloughing of the cornea, or at a later period—when the operation may be performed as directed by Bowman, by the use of a broad needle to break up the lens, and a curette to favor the evacuation of any part that is diffluent. Fully formed, complete staphyloma may be treated by *abscission*, the *seton*, *strangulation*, or *excision of the eye.*

FIG. 343.



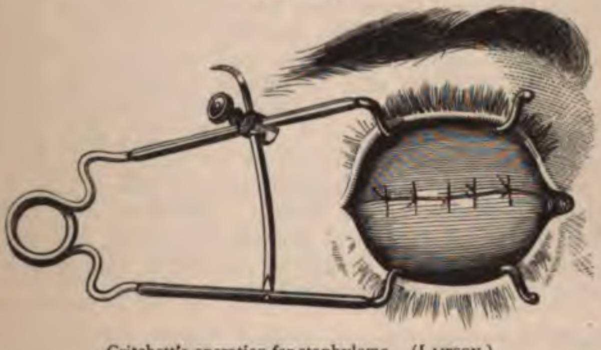
Abscission of staphyloma. (STELLWAG VON CARION.)

(1.) *Abscission* may be performed by either *Beer's*, *Scarpa's*, *Critchett's*, or *Carter's* method. The first consists in transfixing the staphyloma with a Beer's knife (Fig. 343), at the junction of the upper and middle thirds, and cutting downwards. The remaining bridge of tissue is then divided with scissors, and the broad wound left to heal by granulation.

Scarpa's plan differs from the above, in that a flap is formed from the upper part of the staphyloma and laid down over the wound.

Critchett's method consists in passing four or five curved needles, armed with silk, across the base of the staphyloma, and then removing an elliptical segment with probe-pointed scissors introduced through a puncture made with a Beer's knife. The operation is completed by carefully tying the sutures, when a linear wound results (Fig. 344).

FIG. 344.



Critchett's operation for staphyloma. (LAWSON.)

Carter's plan is to unite the recti muscles by catgut sutures, and then close the wound superficially by stitches passed through the conjunctiva only.

(2.) A *seton* may be formed through the base of the staphyloma, as recommended by Von Graefe, the thread being removed in the course of twenty-four or forty-eight hours. Suppurative choroiditis ensues, which induces shrinking and atrophy of the globe, allowing the application of an artificial eye. Wecker employs a thread of carbolized catgut.

(3.) The staphyloma may be *strangulated,* in part or wholly, by Borelli's method, which consists in transfixing the prominence with two needles, introduced at right angles to each other, and throwing around them a fine ligature, as in operating for nævus.

(4.) *Excision of the eye* (the mode of performing which will be described hereafter) is particularly indicated in any case of staphyloma in which the deep portions of the eye are believed to be diseased.

4. Ciliary Staphyloma, when resulting from irido-choroiditis, may be occasionally arrested in its early stages by *iridectomy,* but when caused by a rupture of the sclerotic, is probably incurable. If, in such a case, vision be entirely lost, and the staphylomatous globe a source of irritation, *excision* may be properly resorted to.

Sclerotitis and Cyclitis (*Inflammation of the Sclerotic and Ciliary Body*).—These affections constantly coexist, and are usually secondary to inflammation of the iris or choroid, though they may occur primarily, as the result of traumatic causes. Systematic writers recognize two varieties of cyclitis, the serous and suppurative—the latter being the graver form of the affection.

Symptoms.—There are pain and tenderness in the ciliary region, with photophobia and lachrymation, impairment of vision, increased intra-ocular tension, sub-conjunctival injection (constituting a distinct pink zone around the cornea), cloudiness of the vitreous, dilatation of the veins of the iris, inactivity or distortion of the pupil (from coincident iritis), with, perhaps, turbidity of the aqueous humor, and, in the worst cases, hypopyon. Sclerotitis and cyclitis, in their milder forms, are often seen in rheumatic subjects, constituting what was formerly called *Rheumatic Ophthalmia,* and under this head belongs anatomically the eye affection observed in cases of *gonorrhœal rheumatism* (see page 441).

Treatment.—If the pain be very great, a few *leeches* may be applied to the temple, followed by *warm fomentations* and the administration of *opium.* The state of the *primæ viæ* should be attended to, and the strength of the patient maintained by means of *nutritious food,* and *stimulants* if necessary. *Quinia* may usually be given with advantage, together with the *iodide of potassium,* and the *oil of turpentine* (in drachm doses) if the iris be much involved. *Copaiba* is recommended by A. R. Hall. In a very urgent case it may be proper to administer *mercury,* either by inunction, or internally in combination with opium. Frequent instillations of *atropia* should be practised throughout the course of the disease. *Iridectomy* may occasionally prove beneficial at an early stage of the affection, while, in cases resulting from injury, *excision of the globe* should be resorted to without hesitation, if the other eye be threatened with sympathetic implication.

Episcleritis is the name given to a small, dusky-red, sub-conjunctival swelling, which usually appears on the temporal side of the cornea, and sometimes causes a good deal of irritation and pain, running a very chronic course, and being prone to recur. The *treatment* consists in subduing irritation by the use of atropia, and then employing weak collyria of the chloride or sulphate of zinc. Power recommends the internal administration of a combination of aconite, colchicum, and camphor, while Wecker employs iodide of potassium, and hypodermic injections of pilocarpine. Seely, of Cincinnati, advocates the local use of eserine.

Tumors of the Sclerotic.—Knapp has recorded a remarkable case of intra-ocular enchondroma, originating from the inner layers of the sclerotic. The growth was removed by Chisolm, of Maryland, and ten days afterwards the common carotid artery was tied for secondary hemorrhage, the patient dying from tetanus three days subsequently.

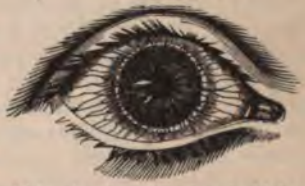
Ossification of the Ciliary Body has been observed by Haynes Walton, and by Lundy, of Michigan.

DISEASES OF THE IRIS.

Iritis, or *Inflammation of the Iris,* may be a primary or a secondary affection. *Primary iritis* may be due to some systemic disease, such as syphilis or rheumatism, or may result from exposure to cold, from injuries, etc. When secondarily involving the ciliary body or choroid, it receives the name of *Irido-cyclitis* or *Irido-choroiditis.* *Secondary iritis* is caused by the extension of inflammation from neighboring structures, as the cornea, choroid,[1] etc. Different classifications of iritis are adopted by authors, the best perhaps being that of Wells, who speaks of the *Simple, Serous, Parenchymatous,* and *Syphilitic varieties.*

Symptoms.—The following symptoms are common to all forms of iritis: (1.) Marked *sub-conjunctival injection,* giving rise to the characteristic ciliary zone, which is easily recognized by its pink color, its deep, sub-conjunctival character, and the radiating course of the enlarged vessels. It is often accompanied by general suffusion of the conjunctiva, and sometimes by chemosis. (2.) A contracted and sluggish state of the *pupil,* which, owing to the formation of adhesions between the iris and capsule of the lens (*synechia posterior*), assumes, when acted upon by atropia, an irregular and distorted outline. If the synechia be complete, the pupil is not at all dilatable, and soon becomes occluded by inflammatory lymph. In *serous iritis,* however, the pupil is often abnormally *dilated.* (3.) The *iris* loses its natural lustre, and becomes discolored; its striated appearance is obscured, owing to inflammatory swelling; its vessels may become enlarged and varicose; while beads of lymph may perhaps be detected upon its surface. The change of color is even greater apparently than in reality, owing to the state of the aqueous humor, which is often turbid from the admixture of flocculent lymph or pus. This may accumulate in such quantities as to form a hypopyon. (4.) *Vision* is impaired, partly by the diminished transparency of the aqueous humor, but also in many cases by the coexistence of *cyclitis,* which alters the accommodation of the eye, and often causes turbidity of the vitreous (p. 674). (5.) *Pain* is usually a prominent symptom of iritis, though in some cases, particularly of the syphilitic form of the affection, it is almost or altogether absent. The pain is deeply seated in the eyeball, and often extends to the forehead, temple, and nose, assuming a neuralgic character, and being worst at night. Tenderness in the ciliary region indicates the presence of cyclitis. (6.) *Photophobia* and *lachrymation* are not usually very intense—much less so, indeed, than in many cases of keratitis.

FIG. 345.



Iritis: showing sub-conjunctival injection forming the ciliary zone. (PIRRIE.

Simple or *Idiopathic* iritis presents the symptoms above described in a mild, and *Parenchymatous* iritis in a severe, form, the latter variety being that in which suppuration chiefly occurs, leading sometimes to perforation of the cornea and permanent loss of sight. *Serous* iritis is especially characterized by the absence of lymphy deposits, and by an increase in the amount of aqueous humor, leading to augmented intra-ocular tension and consequent *dilatation* of the pupil. Serous iritis often accompanies choroiditis and retinitis, and is the form sometimes assumed by *Sympathetic Ophthalmia;* it is also seen in connection with hereditary syphilis. The so-called *Rheumatic* iritis belongs to one or other of the above varieties, and is often associated with sclerotitis in cases of gonorrhœal rheumatism (pp. 441, 674). The true *Syphilitic* iritis belongs to the parenchymatous variety of the affection, being an accompaniment of *tertiary* syphilis, and characterized by a deposit of yellow tubercles which are strictly analogous to gummatous tumors (p. 459); the iritis of *secondary* syphilis, on the other hand, is an ordinary iritis, simple, serous, or parenchymatous, which is not essentially dependent on syphilitic infection (see p. 457). S. M. Burnett describes, under the name of *spongy* or *fibrinous iritis,* a form of the disease characterized by intense pain and very rapid and extensive exudation of a fibrinous material, which is subsequently absorbed, the absorption beginning at the periphery.

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[1] Hence some systematic writers describe *choroido-iritis* separately from *irido-choroiditis.*

Any form of iritis may be met with as a *recurrent* affection, particularly in rheumatic and syphilitic persons.

Treatment.—The use of *atropia*[1] is unquestionably the most important point in the treatment of iritis. A strong solution should be employed (at least gr. iv to f℥j), and this may be applied in very urgent cases, as advised by Wells, at intervals of five minutes, for half an hour, three times a day. The advantages gained by the use of atropia are the dilatation of the pupil, thus preventing the occurrence of synechia posterior, the physiological rest secured to the iris by paralyzing its circular fibres, and the diminution of intra-ocular tension. Even if adhesions to the capsule of the lens are already formed, these can often be stretched and even ruptured by the unsparing use of atropia. Hypodermic injections of *morphia* may be administered to relieve pain, and the same remedy may be employed as an antidote in the rare event of a poisonous effect being produced by the passage of atropia through the lachrymal puncta into the throat. *Leeches to the temple* are often serviceable in relieving the intense ciliary neuralgia, and are also of use in lessening intra-ocular tension, and thus preparing the way for the action of atropia. *Paracentesis of the Cornea* may also be employed for the latter purpose, and is particularly indicated if the aqueous humor be cloudy, or if hypopyon be present. *Mercury* is certainly a valuable remedy in those cases of iritis in which there is an abundant formation of inflammatory lymph, but is by no means so essential as was formerly supposed. It may be given internally, in combination with opium, or may be employed by inunction. *Iodide of potassium* and *oil of turpentine* are particularly useful in cases of syphilitic and rheumatic iritis. *Copaiba* is recommended by Macnamara, Hall, and other Indian surgeons, and the salicylate of sodium by Chisolm, of Baltimore. Finally, *iridectomy* may be required, if there be extensive and firm adhesions between the iris and capsule of the lens, or if, as in some cases of serous iritis, there be a marked increase of intra-ocular tension.

Tumors of the Iris.—If of a *cystic* nature, the proper remedy is *iridectomy,* the cyst being removed with its seat of attachment. *Excision of the entire*

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[1] As a mydriatic for use in correcting errors of refraction, Dr. S. D. Risley prefers a two-grain solution of the sulphate of duboisia, or a two- to six-grain solution of homatropine hydrobromate.

iris was suggested by Mr. R. B. Carter in a case in which both irides were the seats of *round-celled sarcoma*, and excision of the growth alone, by an operation analogous to that of iridectomy, has been successfully practised by Kipp, of Newark, and other surgeons. *Melanotic cancer* of the iris demands *excision of the globe*, which is the only mode of treatment offering even a hope of benefit.

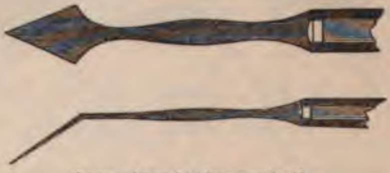
Mydriasis (*Dilatation of the Pupil*) may result from rheumatism affecting the nerve sheaths, from syphilis, from contusions or other injuries, from irritation of the sympathetic, from cerebral disease, or from any disease of the eye which produces increased tension of the globe. Paralysis of the ciliary muscle often coexists, producing disturbance of the accommodation. The accompanying impairment of vision, if due to mydriasis alone, may be relieved by the use of a diaphragm with a pin-hole perforation; while the paralysis of accommodation will often yield to the application of a blister behind the ear, and the administration of iodide of potassium. In chronic cases, a weak solution of Calabar bean may be dropped into the eye.

Myosis (*Contraction of the Pupil*) may result from excessive use of the eyes, as in watchmaking or engraving, or may depend upon disease of the cervical portion of the spinal cord, the pressure of an aneurism or tumor on the cervical sympathetic, etc. Little can usually be done in the way of *treatment*, though temporary relief may sometimes be afforded by the instillation of atropia.

OPERATIONS ON THE IRIS.

Iridectomy.—This operation consists in the excision of a portion of the iris. When done for the relief of intra-ocular tension (as in glaucoma), or as a preliminary to extraction of cataract, the section should, as a rule, be made upwards; though as the outward section is an easier procedure, this may be sometimes preferred by an inexperienced operator. The advantage of an upward iridectomy is that the lid subsequently covers the seat of operation, thus cutting off the irregularly refracted peripheral rays of light, and at the same time partially hiding the resulting deformity. If, on the other hand, an iridectomy is to be performed as a means of making an artificial pupil, a small inward section is preferable—the visual line cutting the cornea on the inner side of its central point—though, in cases of corneal opacity, the surgeon may be forced to make his section at any point opposite to which the cornea may happen to be clear.

FIG. 346.



Lance-shaped iridectomy knife.

Iridectomy is thus performed: The patient being in the recumbent position, and under the influence of an anæsthetic,[1] the surgeon separates the lids by means of a Liebreich's, Noyes's, or ordinary spring-top speculum (Fig. 344), and, standing behind the patient's head, fixes the eye by seizing with firm catch-forceps the conjunctiva and subjacent fascia, at a point directly opposite to that of the proposed section. A lance-shaped *keratome* or *iridectomy knife* (Fig. 346)—straight for the outward, but angular for the upward or inward section—is then to be thrust through the sclerotic at about half a line or a line from its junction with the cornea, the handle being well depressed, so as not to wound the iris or lens, while the blade is slowly thrust onwards, until the section is of the desired extent. The knife is then cautiously withdrawn, so as to allow the slow escape of the aqueous humor, when the *first* stage of the operation is completed. The fixation forceps are now handed to an assistant, who may rotate the globe a little downwards, and steady it while the surgeon excises a portion of the iris; this *second* stage of the operation is accomplished by introducing curved iris forceps (Fig. 347), expanding the blades so as to grasp the pupillary margin, cautiously withdrawing the forceps with the included portion of iris, and snipping off the latter close to the wound by one or two cuts with delicate curved scissors. When the object of the operation is to reduce intra-ocular tension, the iris should be excised close up to its ciliary margin. Sometimes, immediately after the withdrawal of the knife, the iris prolapses, when it may be instantly seized with forceps and excised. If the anterior chamber be very shallow, it may be safer to substitute, for the lance-shaped instrument, the knife used by Von Graefe for the modified linear extraction of cataract, making a puncture and counter-puncture, and then cutting outwards as in the operation referred to. If the section of the iris cause hemorrhage into the anterior chamber, the escape of blood may be facilitated by carefully introducing a curette (Fig. 354, *b*), and making cautious pressure with the fixation forceps. The speculum being removed, the lids are gently closed, and a *compressing bandage* applied. This is done by covering the closed lids with an oval disk of soft linen, spread with simple ointment or glycerin to prevent its adhering, filling up the inequalities of the orbit by carefully packing the part with fine charpie, and finally securing the whole with a Liebreich's (Fig. 348), Theobald's, or other light bandage. For the first few days, *both* eyes should be excluded from the light.

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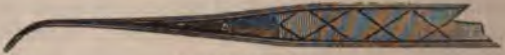
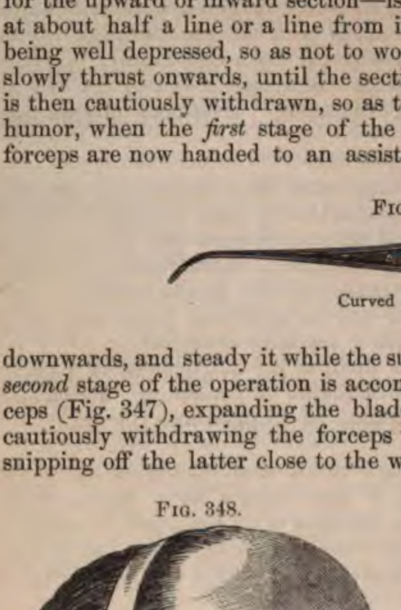
[1] Abadie recommends the preliminary hypodermic use of ergotine, as a means of preventing intra-ocular hemorrhage.

FIG. 347.



Curved iris forceps.

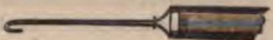
FIG. 348.



Liebreich's bandage. (LAWSON.)

Iridectomy for Artificial Pupil requires a *smaller* section, which should be made through the *cornea*—as in this case it is desirable to leave the ciliary attachment of the iris, so as to cut off some of the peripheral rays; the portion of iris which is to be excised may be drawn out with forceps, or with a blunt silver or platinum Tyrrell's hook. R. B. Carter has modified this operation by cutting off a portion of the iris with delicate scissors (Wecker's) introduced into the anterior chamber of the eye, and subsequently withdrawing the severed fragment with forceps.

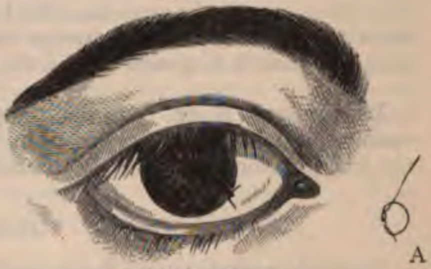
FIG. 349.



Tyrrell's hook.

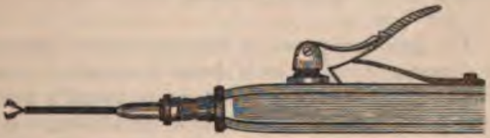
Iridodesis.—This operation was introduced by Critchett, and is adapted to the formation of an artificial pupil in cases of opaque or conical cornea, lamellar cataract, etc. It is performed by making an incision, with a broad needle, at the junction of the cornea and sclerotic, a loop of fine black silk (Fig. 350, A) being laid around the wound as soon as the needle is withdrawn. An iris hook is then passed *through* the loop, and into the anterior chamber, seizing a portion of iris by its pupillary margin, and bringing it out, when the loop is tightened by an assistant drawing with forceps upon its free extremities. The ends of the ligature being cut off, the eye is bandaged, the loop coming away in two or three days, and leaving the iris adherent to the point of incision. If it be only desired to displace or enlarge the original pupil, the peripheral portion of the iris may be seized with canula forceps (Fig. 351), introduced through the loop (instead of the hook), the remainder of the operation being conducted as already described. A *double iridodesis* (one downwards, and, after several days, another made upwards) has been recommended by Bowman in cases of conical cornea.

FIG. 350.



Iridodesis. (LAWSON.)

FIG. 351.



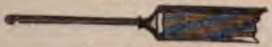
Canula forceps.

Artificial Pupil by Incision (Iridotomy).—This operation may be practised in cases in which the lens is absent (as after cataract extraction), and in which the pupil is entirely occluded. It is performed by simply splitting the fibres of the iris with a broad needle, the retraction usually affording a sufficient pupil. Under other circumstances, a Tyrrell's hook may be introduced, and the operation converted into a small iridectomy. Bowman has modified this operation by excising a triangular-shaped piece of iris, with delicate scissors introduced through a corneal wound. Iridotomy is also employed by Bowman and Wecker in cases of zonular cataract, opacity of the cornea, etc., the former surgeon employing a knife blunt at the point and back, which is introduced behind the iris and made to cut forwards, and the latter employing a triangular keratome and delicate forceps scissors.

Wecker's operation has also been successfully employed in a number of cases by Dr. H. D. Noyes, of New York.

Corelysis is an operation practised by Streatfield and Weber, for the detachment of adhesions passing between the pupillary margin of the iris and the capsule of the lens. It consists in making, with a broad needle, a corneal wound at a convenient point, and then with a spatula-hook (Fig. 352) passed behind the adhesion, drawing forwards and slowly rupturing the latter.

FIG. 352.



Spatula-hook.

Passavant's Operation, for the accomplishment of the same object, consists in making a *small* opening at the edge of the cornea, introducing suitable forceps and seizing a fold of the iris in close proximity to the synechia; the latter is then torn loose from its attachment to the lens, and the forceps disengaged and cautiously withdrawn, care being taken to guard against the occurrence of prolapse of the iris.

Iridodialysis is an operation employed in cases of extensive *central* opacity of the cornea; it consists in tearing loose the *ciliary attachment* of the iris, thus forming a *peripheral* artificial pupil.

CATARACT.

An opaque condition of the crystalline lens, of its capsule, or of both, is called *cataract*, the several conditions being distinguished by the names *lenticular*, *capsular*, and *capsulo-lenticular*. A collection of lymph or blood in front of the lens is sometimes called *spurious cataract*. Cataracts are classified according to their mode of origin, as *idiopathic*, *traumatic*, or *congenital;* according to their color, as *black*, *amber*, etc.; and according to the consistence of the cataractous lens, as *hard* or *soft*. *Ossification* of the crystalline lens has been observed by Walton, Keyser, and Voorhies, of Memphis.

Symptoms.—The first symptom of cataract which attracts the attention of a patient, is *dimness of vision*, as if from a cloud or mist, which, in idiopathic cases, comes on gradually; the sight is usually best in a somewhat dim light, for the pupil dilates under such circumstances, and allows light to penetrate the *periphery* of the lens, which is usually less opaque than its *centre*. The appearance of a *cataractous* patient differs from that of one who is *amaurotic:* the former has not the vacant stare of the latter; instead of helplessly rolling up his eyes to the sky, he is able to direct them towards any object with some certainty, and, to a moderate extent, he can find his way about by himself; there is no involuntary oscillation of the eyeball, nor divergent squint, and the pupil reacts normally to the stimulus of light. In a case of *uncomplicated* cataract, the power of distinguishing day from night is never lost. In a case of advanced cataract, the opacity can be readily recognized by the unaided eye of the surgeon, but in an earlier stage more careful examination may be necessary.

The *Catoptric Test*, which was proposed by Sanson, is now, since the introduction of the ophthalmoscope, seldom employed, but is still worthy of mention: if a lighted candle be moved before a healthy eye, *three* images of the flame will be seen; *two erect*, formed by reflection from the convex cornea and anterior surface of the lens, and *one inverted*, from the concave posterior surface of the latter. If now the lens be opaque, the inverted image will be wanting, the deeper erect image similarly disappearing when the opacity involves the capsule, and the corneal image being then alone perceptible.

The diagnosis of cataract may be most satisfactorily made by means of *Oblique Illumination* and the *Ophthalmoscope*. *Oblique illumination* (Fig. 173) is practised by placing the patient in a darkened room, and with a convex lens, concentrating the light from a suitably-placed Argand lamp upon the pupil, previously dilated with atropia—when any opacities may be readily recognized by their *whitish-gray* color. When now the light is reflected by means of the *ophthalmoscopic mirror* into the eye, the opacities appear as streaks or spots, which are *black* from the interference with the return of light from the fundus oculi; or if the opacity be of a diffused character, the ordinary red hue of the fundus may be partially or completely obscured.

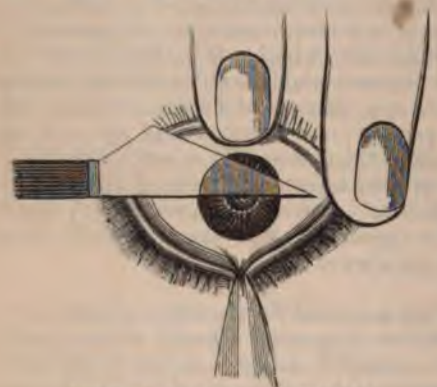
The most important practical points in the examination of a cataract are to determine—*first*, whether it be or be not complicated by the presence of some more deeply seated lesion, and *secondly*, whether it be *hard* or *soft*. In a case of *uncomplicated* cataract, the patient should be able to distinguish the light of an ordinary Argand burner at a distance of fifteen or twenty feet. *Hard* cataracts usually occur in persons over fifty years of age, and are probably never met with in those under thirty-five. They are commonly of a smoky-ash color, and frequently present a regularly striated appearance; after extraction they have an amber tint. *Soft* cataracts are most frequent in the young, present a bluish-white appearance, and are irregularly, if at all, striated. *Congenital* cataracts are always soft.

Treatment.—Various operations are practised for the relief of cataract—all having for their object the immediate or gradual removal of the opaque lens. In cases of *lamellar* or *zonular* cataract, however (a variety of soft cataract met with in children, and according to Arlt, in connection with a history of convulsions, and in which an opaque lamella or zone intervenes between the nucleus and cortical portion, which are both clear), if the disease be not progressive, an *iridodesis* may be preferable to any operation upon the lens itself (see p. 679). Before resorting to any operation for cataract, the surgeon should test the sensibility of the retina to light, as unless the patient, when placed in a dark room, is able to recognize the presence and general position of the flame of a lamp at a distance of fifteen to twenty feet, the prospect of benefit from an operation will be comparatively slight. With regard to the *time* for operation, it may be said that *congenital* cataracts should be operated upon at an early period, as otherwise a disfiguring involuntary habit of oscillation of the eyeballs (*nystagmus*) is apt to be developed; in other cases it is better, as a rule, to wait until the cataract is fully *ripe* or *mature*, or, in other words, until the whole lens has become opaque. In cases of *double* cataract, that which is furthest advanced should be first operated upon, so that the patient may continue to use the second eye while the process of cure in the first is going on. *Chloroform* may be administered in any operation except that of flap extraction; the patient should lie on a table of convenient height, with a good side light, and with the pupil well dilated by atropia. I shall not attempt to describe all the varieties of operation which have been and are practised for the cure of cataract, but shall speak merely of the ordinary flap operation, the traction method, and that of Von Graefe, the needle operation (or that of solution), and the suction method. The first three are adapted for *hard*, and the last two for *soft*, cataracts. The old operation of *Reclination*, *depression*, or *couching*, by which the lens was forcibly thrust down into the vitreous (where it constantly gave rise to destructive inflammation), is now happily almost totally abandoned, and is mentioned merely as a matter of historical interest.

OPERATIONS FOR CATARACT.

Extraction by Flap Operation.—In this operation the use of chloroform is not admissible. The surgeon, if able to use the knife with his left as well as with his right hand, may stand behind the patient's head, no matter which eye is to be operated upon; under other circumstances, he should take this position for the right eye only, standing on the patient's left side and in front, for an operation on the left eye. The peculiarity of this method consists in making a large semicircular flap, involving half the cornea, and the operation may be done either by an upward or downward section, the former being usually preferred. The following description refers to the operation by *upward* section on the *right* eye. It is usually best to dispense with specula in this procedure, the eye being fixed by the fingers of the surgeon and his assistant;[1] the former with his left forefinger raises the upper lid, and holds its tarsal edge firmly beneath the upper border of the orbit, while his middle finger is fixed steadily on the inner canthus, the assistant in the same way depressing the lower lid, and fixing the outer canthus; the eye is thus securely held without injurious compression. If, however, the patient be very restless, the surgeon may himself fix the eye with forceps, intrusting the raising of the upper lid to his assistant (Fig. 353).

FIG. 353.



Flap extraction of cataract. (WELLS.)

The surgeon then, standing behind the patient, and holding the triangular extraction knife lightly in his right hand, enters its point half a line within the sclero-corneal junction on the temporal side, at first in the direction of the radius of the corneal curve, so as not to split the lamellæ of the cornea, but keeping the blade subsequently in a plane parallel to that of the iris. The flap is made by simply pushing the blade across the anterior chamber, the point of exit being diametrically opposite to that of entrance; the peculiar shape of the blade causes it to constantly fill the wound, and thus prevents the premature escape of the aqueous humor. If fixation forceps are used, they should be disengaged as soon as the counter-puncture is effected. The flap being completed, the eyelids are allowed to close for a few seconds, when the surgeon proceeds to the *second*[2] stage of the operation, the laceration of the lens capsule. This is effected by introducing the cystotome (Fig. 354, *a*), the patient looking downwards, and the upper lid being slightly elevated; when the cystotome has reached the inner side of the pupil, its point is turned downwards, and the capsule freely divided as far as the outer pupillary margin; the instrument is then cautiously withdrawn, when the eyelids may again be allowed to close. The *third* stage of the operation consists in the evacuation of the lens, which is effected by making gentle pressure with the back of the curette (Fig. 354, *b*) upon the lower lid, while counter-pressure is made with the forefinger upon the upper portion of the eyeball. The curette should at first press backwards, and then backwards and upwards, so as to cause the lens to present itself edgewise at the corneal wound. The pressure must be very cautiously made, lest rupture of the hyaloid membrane and loss of vitreous follow. The operation is now completed, but before applying the after-dressing the surgeon should again, in a few minutes, separate the lids, to make sure that the corneal flap is properly adjusted, and that no prolapse of the iris has occurred. The after-treatment consists in closing the eye with a single strip of isinglass plaster, and applying a *compressing bandage* (see p. 678) to *both* eyes. The patient should be confined to bed for three or four days. Dr. H. W. Williams (*Boston City Hospital Reports*, 1870, p. 378) recommends the insertion of a delicate suture in the centre of the wound after the operation of flap extraction; his statistics do not, however, show any particular gain by the proceeding—102 cases *with suture* having given 85 successes, 8 partial successes, and 9 failures, while 104 cases *without suture* gave 87 successes, 7 partial successes, and 10 failures. If all goes well, the eye should not as a rule be opened until the end of a week, though the external dressing may be renewed once or even twice a day. Should, however, the occurrence of any unfavorable symptom, such as great pain, swelling, or muco-purulent discharge, lead the surgeon to fear that the case is not progressing satisfactorily, the lids should be gently separated and the eye inspected (by the light of a candle), that the exact condition of things may be recognized, and appropriate treatment resorted to.

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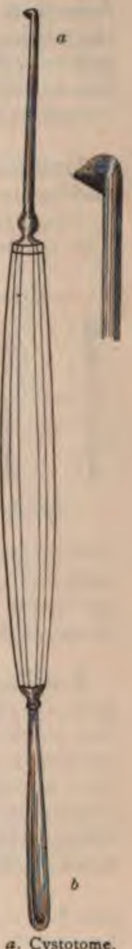
[1] Chesshire, of Birmingham, recommends division of the external canthus as a preliminary to all cataract operations, so as to avoid the risk of injurious pressure from sudden contraction of the orbicularis palpebrarum muscle.

[2] Correnti, of Florence, and Spencer Watson recommend that the laceration of the capsule should, in both this and Von Graefe's operation, be effected *before* making the flap, by means of a curved cataract needle introduced through the cornea from the temporal side.

FIG. 354.



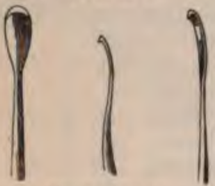
a. Cystotome.
b. Curette.

The chief *complications* which may arise during the operation are as follows: (1) the iris may fall in front of the knife—to be remedied by gently disentangling the point of the instrument, and by making cautious pressure through the cornea; if this fail, the section may be completed, the resulting iridectomy not being of any particular disadvantage; (2) the corneal wound may be too small—to be remedied by cautiously enlarging it with blunt-pointed knife or scissors; (3) the lens may drop down into a fluid vitreous—the lens must be instantly extracted with a suitable spoon or hook, and a compressing bandage applied; (4) prolapse of the iris may occur—to be remedied by gently repressing the protruding portion with a fine probe, or by softly rubbing the lids in a circular direction; if this fail, the prolapse should be seized with forceps and excised; (5) portions of the cortical matter of the lens may be detached during its exit—these should, if possible, be removed by very gently rubbing the eyelids in a circular direction, so as to bring the fragments into the anterior chamber, whence they may be removed with a scoop or spoon. If, from its transparency, the cortical matter at first escape observation, subsequently swelling and producing irritation, atropia must be freely used; it may even be necessary to make a small corneal incision, facilitating the escape of the remaining lens substance by means of the curette or *suction apparatus* (see p. 686).

The escape of a considerable quantity (more than one-third) of the vitreous humor is usually followed by loss of the eye, and an equally bad result attends deep intra-ocular hemorrhage, which may occur during the operation, or some hours subsequently. Failure after flap extraction may occur from these causes, or from inflammation attacking the cornea or iris, or even the whole globe; the treatment of these accidents must be conducted upon general principles—the application of a few leeches to the temples, and the free use of atropia, are to be recommended during the early stages, followed by warmth and moisture, and the compressing bandage, if suppuration occur.

Traction Method.—In this operation (which originated with Von Graefe and has been modified by Waldau, Critchett, and others), chloroform may be employed, and the eyelids may be held apart with the stop-speculum. The surgeon, standing behind the patient, fixes the eye with forceps, and makes with an iridectomy knife, or a Graefe's linear extraction-knife, an incision in the upper part of the sclero-corneal junction, involving *one-third* of the corneal circumference; the fixation forceps are then intrusted to an assistant, and the surgeon, cautiously introducing delicate iris forceps, makes a broad iridectomy as directed at page 677. The capsule of the lens is then freely lacerated with the cystotome, and the lens itself drawn out with a silver spoon (Fig. 355), provided with a barbed or recurrent edge, which allows it to slip easily between the lens and the posterior capsule, and then catches the lower edge of the lens and holds it firmly as it is withdrawn. Care must be taken in the introduction of the spoon, not to push the lens before it, and not to rupture the hyaloid membrane, which would allow loss of vitreous.

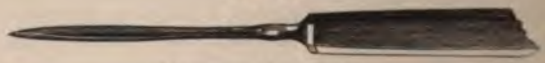
FIG. 355.



Traction spoons.

Von Graefe's Method of Modified Linear Extraction, with its lamented author's latest modifications, may, probably, be considered the best operation yet devised for extraction of cataract. The peculiarities of this method are that the incision is through the sclerotic, and does not form a flap,[1] and that no traction instrument is employed. The following description and accompanying wood-cuts are taken from Laurence; the eye operated upon is supposed to be the left. The surgeon opens the extreme periphery of the anterior chamber with a narrow knife, represented at Fig. 356 in its actual size, by an incision A B (4½–4¾ lines long) through the sclerotic, at the point A (Fig. 357), half a line external to the margin of the cornea, and two-thirds of a line below the level of its uppermost summit. The point of the knife is, in order to enlarge the internal corneal incision, in the first

FIG. 356.



Von Graefe's cataract knife.

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[1] The incision is usually said to be *linear* (whence the name of the operation), but this distinction is not mathematically correct, the section in this method no more corresponding to the geometrician's definition of a line than does that of the ordinary flap operation. The curve in Graefe's incision is that of the eye itself.

instance, directed, not to the point of counter-puncture B, but to about the point C. After the knife has been entered fully three lines into the anterior chamber, its handle is depressed, counter-puncturation at B effected, the knife-edge directed abruptly forwards, and the section completed. In Fig. 357*a*, the uppermost undotted line shows the direction of the incision.[1] The next steps of the operation are the same as in the traction method, consisting in an iridectomy and the laceration of the anterior capsule.[2] To remove the lens, a spoon of vulcanite or tortoise-shell is employed, not being used as a traction instrument, but simply to exercise pressure from without. The convex back of the instrument is applied to the lower border of the cornea, when, by using a little pressure, the wound at its upper part begins to gape. Then the spoon is given a slight turn (so that its upper border buries itself a little in the outer surface of the cornea), at the same time that it is moved a little upwards, in consequence of which the equator of the lens presents itself at the wound. By continuing this manœuvre and making slight counter-pressure on the scleral border of the wound, the exit of the lens is effected. Any cortical matter which may have become detached is to be coaxed out by gently stroking the cornea from below upwards with the back of the spoon, as long a time as may be necessary being devoted to the satisfactory accomplishment of this final part of the operation.

FIG. 357. FIG. 357*a*.

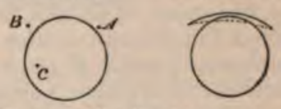
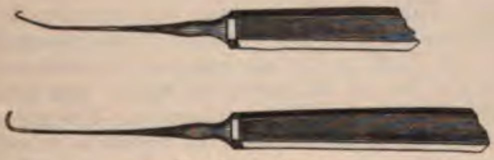


Diagram of Von Graefe's operation for cataract.

If in any case the evacuation of the lens in the manner described be found impracticable, it may be extracted with a silver spoon, or (which Graefe prefers) a blunt hook (Fig. 358).

FIG. 358.



Von Graefe's hook.

The after-treatment in this and in the traction method is the same as in the flap extraction, except that in these the eye may be safely examined after twenty-four hours, and the patient allowed to leave his bed on the second or third day.

Various modifications of Graefe's method, or combinations of it with the old operation of extraction, have been proposed by Warlomont, Liebreich, Bader, and other surgeons.

Needle Operation, or the Operation for Solution.—This is the method ordinarily to be preferred for the removal of soft cataracts. Chloroform or ether may be indiscriminately employed, but neither is usually required. The pupil being well dilated, and the lids separated by the stop-speculum, the surgeon fixes the eye with forceps, and enters a lance-headed, or, if preferred, a Hays's knife-needle, through the cornea at its outer side, and carries it across to the centre of the pupil, when the edge is turned to the lens, and a slight laceration made in the capsule. The operation usually has to be repeated at intervals. Care must be taken not to use so much force as to dislocate the lens, and not to lacerate the capsule too freely in the first operation, lest the lens substance, swelling up from the contact of the aqueous humor, should produce injurious pressure on the iris and ciliary body. When the bulging lens matter has disappeared by absorption, the operation may be repeated, the needle this time being used more freely. The only after-treatment required is the closure of the eye for twenty-four hours, and the maintenance of pupillary dilatation by means of atropia. If the lens be dislocated, it should, as a rule, be removed by means of a corneal incision and the introduction of a scoop, an iridectomy being at the same time performed; while, if the swelling of the lens be so great as to threaten injurious consequences, a small incision, with a keratome or broad needle, may be made, and the escape of the offending substance aided by the introduction of a curette.[1] Wharton Jones practises an operation, under the name of *discission from behind*, in which the needle is introduced through the sclerotic, behind the iris, and made to lacerate the posterior wall of the capsule.

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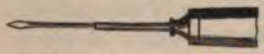
[1] Knapp and C. R. Agnew advise that the middle of the incision should come almost to the sclero-corneal junction.

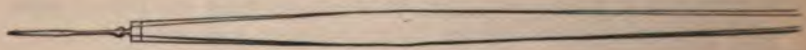
[2] Knapp and Fitzgerald advise a peripheral division of the capsule, corresponding to the line of the corneal wound.

FIG. 359.



Bowman's stop-needle.

FIG. 360.



Hays's knife-needle.

Suction Method.—This operation, which was introduced by Teale, is specially adapted to cases of fluid cataract, such as are frequently met with in diabetic patients. Mr. Teale used a "suction curette," consisting of a curette roofed in to within a line of its extremity, with a handle and a piece of India-rubber tubing furnished with a mouth-piece. The anterior capsule of the lens being lacerated with two needles, the curette is introduced through a small corneal wound into the area of the pupil, and the fluid lens matter sucked out by the application of the operator's mouth. Mr. Bowman has devised a "suction syringe," which is in some respects more convenient than the curette.

Treatment of Capsular and Secondary Cataract.—It sometimes happens that, after the removal of a cataractous lens, the field of vision is still obscured by an opaque or wrinkled condition of the remaining capsule, containing, perhaps, some portions of lenticular matter inclosed within its layers; the obstruction may be aggravated by the presence of nodules of inflammatory lymph. No operation should be practised for the relief of this condition until all the irritation caused by the original operation has passed away, an interval of several months being usually required. The safest mode of treating secondary or capsular opacities is to tear through the occluding membrane with a Hays's needle, introduced through the cornea. If the capsule be very dense and resisting, two needles, introduced at opposite sides of the cornea, may be used, as advised by Bowman—one serving to fix the membrane while laceration is effected with the other. Other plans are to divide the capsule with delicate "canula scissors" (Fig. 361), to tear it with toothed forceps, as practised by Higgens, of Guy's Hospital, or, as recommended by C. R. Agnew, of New York, to perforate and fix the membrane with a needle, and then with a sharp hook, introduced through a small corneal opening, to tear and roll up the membrane, which, if not too closely attached, may be drawn out with the instrument. E. G. Loring employs a very delicate and narrow knife, with which he punctures the sclero-corneal junction, and then freely cuts through the iris as well as the capsular cataract.

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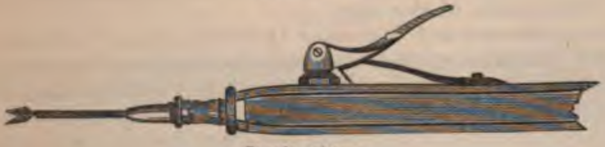
[1] The operation is thus essentially converted into the true "*linear extraction*," which originated in 1811 with Gibson, of Manchester.

FIG. 361.



Canula scissors.

After these, as after other cataract operations, the pupil should be kept for some time well dilated with atropia.

DISEASES OF VITREOUS HUMOR, CHOROID, RETINA, AND OPTIC PAPILLA.

(*Amaurosis and Amblyopia.*)

Amblyopia and amaurosis are, strictly speaking, *symptoms*, the former word denoting *obscurity*, and the latter more or less complete *loss of vision.*[1] These terms are ordinarily applied to all cases of partial or total blindness, which are dependent neither on external obstructions (such as cataract or opaque cornea) nor upon optical defects of the eye, but are limited by Von Graefe and many other modern ophthalmologists, to cases of lost or impaired vision which are caused by *primary atrophy of the optic nerve*, or by such *irregularities in the circulation of the nervous system* as may eventually lead to such atrophy.

Looking, then, upon these conditions (amblyopia and amaurosis) as *symptoms* of disease, rather than as definite pathological states which can be referred to any particular cause, I shall first speak of the morbid changes in the deeper structures of the eye, to which their manifestation may be due, and subsequently of those cases of *nervous blindness* to which alone Von Graefe and his followers would apply the term *amaurotic.*

The Ophthalmoscope.—These cases can only be investigated by the aid of the ophthalmoscope, a brief account of which instrument may, therefore, be appropriately given in this place. The ordinary form of ophthalmoscope consists essentially in a *perforated mirror*, by which the light from a suitably placed lamp is reflected into the patient's eye, and thence back to that of the surgeon, who looks through the central perforation. *Liebreich's portable ophthalmoscope*, which is convenient for general use, consists of a polished, concave metallic mirror, about 1¼ inch in diameter and of 6 to 8 inches focal length. It has a central perforation about a line in diameter, and is mounted in a light frame with a handle of convenient length. A movable arm, attached to the side of the frame, supports a clip, in which may be placed, behind the sight-hole, an ocular lens, either concave or convex, according to the needs of the observer. Accompanying the ophthalmoscope is a double-convex object lens, for use in the method of *indirect* examination. More perfect but more complicated forms of ophthalmoscope have been devised by surgeons, but are, perhaps, less well adapted to the purposes of the general practitioner than that which has been described. Among the most ingenious may be mentioned those of Loring and Knapp, of New York, and Shakespeare, of this city.

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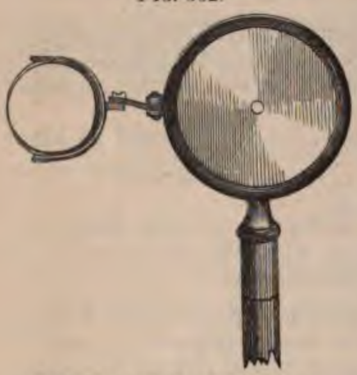
[1] Etymologically the words are synonymous, both signifying, literally, *dimness of vision*.

Fixed Ophthalmoscopes and *Binocular Ophthalmoscopes* (in which the surgeon uses both eyes at once) have each some particular advantages in special cases. Prof. Beale has devised a *self-illuminating ophthalmoscope*, which, by an ingenious arrangement of lamp and mirror (the latter of which is inclosed with the object lens in a darkened tube), can be used without the necessity of previously darkening the room.

Fig. 362.



Liebreich's portable ophthalmoscope.

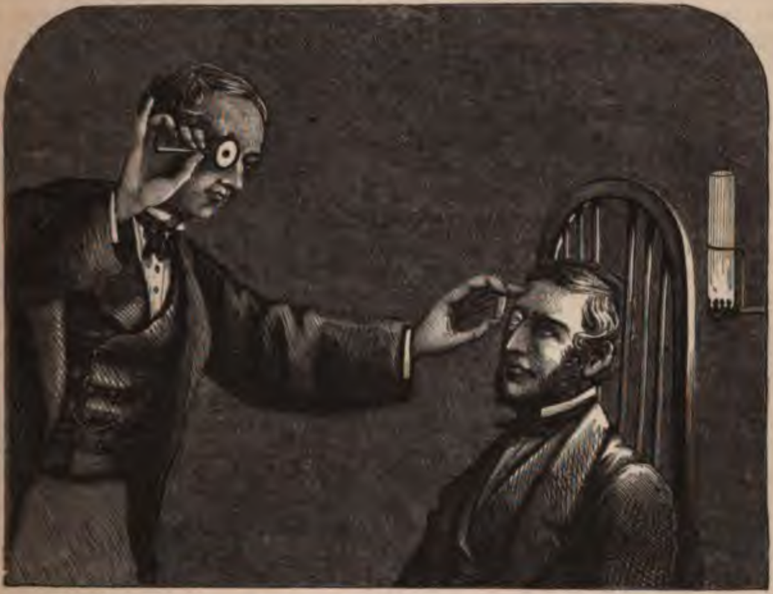
The ordinary ophthalmoscope is used in a darkened room, the patient being firmly seated, and the surgeon standing or sitting in front of him; an Argand lamp or gas-burner is placed to one (usually the left) side of, and a little behind, the patient's head, with the flame on a level with his eyes. The patient's pupil may, if deemed necessary, be dilated with atropia.

For the *indirect* method of examination, which is that commonly employed, the surgeon holds the mirror close to his own eye, and about a foot and a half from that of the patient. Looking through the central perforation, the surgeon is soon able, by a little manœuvring, to catch the rays from the lamp and reflect them directly into the patient's eye, the pupillary space of which now appears of a reddish-yellow color. Then taking in the other hand the object lens, the surgeon holds it from an inch and a half to two inches in front of the eye which he is observing, fixing it in that position by resting his fingers on the patient's forehead. By now moving his own head a little backwards or forwards, the operator obtains an *inverted aerial image* of the fundus of the observed eye. By directing the patient to turn his eye in various directions, the surgeon can explore the whole fundus of the eye, it being remembered that, in the aerial image which is seen, the position of every part is inverted.

In the *direct* method of examination, no object lens is used. The surgeon at first holds the mirror about a foot from the eye of the patient, and then, by gradually approximating it more closely, can illuminate and examine in succession the cornea, crystalline lens, and vitreous; the fundus oculi is not fairly brought into view until the mirror is within about two inches of the observed eye, when a *virtual erect image* becomes apparent, seeming to be placed some distance behind the patient's eye. If either the surgeon or patient be short-sighted, a concave lens must be placed behind the sight-hole of the mirror.

The *entrance of the optic nerve*, which is usually the part first inspected, may be brought into view by causing the patient to look at that ear of the operator which corresponds to the eye under examination; thus, the right ear for the right eye, and the left for the left. The optic papilla gives a whiter reflection than the rest of the fundus, and, when brought into distinct view by the adjustment of the object lens (in indirect examination), appears as a pinkish, white, or gray disk, marked by the convergence of the *retinal vessels;* of these, one artery and two veins commonly pass upwards, and as many downwards, each soon dividing and ramifying over the fundus. The veins may be made to pulsate by pressing on the eye, and sometimes do so spontaneously in a normal state. Spontaneous pulsation of the retinal arteries, on the other hand, is always an evidence of increased intra-ocular pressure, and is a symptom of glaucoma. The *macula lutea,* or *yellow spot,* may be brought into view by directing the patient to look at the central perforation of the mirror, and may be recognized by the absence of retinal vessels. The macula lutea is frequently the seat of hemorrhagic extravasations or other lesions.

Fig. 363.



Use of the ophthalmoscope. (Erichsen.)

It not my purpose to offer any detailed account of the various ophthalmoscopic appearances observed in different morbid states of the eye: the limits of this volume would not justify my doing so, and, indeed, as justly remarked by Dixon, it is not possible to convey, by mere verbal description, any information upon these topics which would be of much real value. The use of the ophthalmoscope can only be satisfactorily acquired by long and continued actual practice, and the assistance which the student can derive from any verbal description of what he is expected to see will not prove of material advantage. Those, however, who cannot pursue their labors in this branch under the direction of an experienced and skilful ophthalmoscopist (which is much the best manner of acquiring a practical knowledge of the instrument), may study with benefit the works of Zander and Hulke, and the colored illustrations of ophthalmoscopic appearances published by Jæger, Liebreich, Stellwag, Power, Wells, and others.

The morbid changes of the deep structures of the eye which induce amaurosis and amblyopia may now be briefly referred to.

Changes in the Vitreous Humor. *Opacities of the Vitreous.*—These may consist of filaments of lymph, shreds of pigment, or the contracted remnants of blood clots. They result frequently from diseases of the iris, retina, or choroid, especially when of a syphilitic character—in which case they are to be treated by means of remedies addressed to that condition. Dense membranous opacities have been successfully treated by Von Graefe by means of a needle-operation, as in cases of capsular cataract. The use of the continuous galvanic current is recommended in these cases by Onimus and Carnus, by Lefort, and by Teulon, who reports 22 cures among 24 cases thus treated.

Muscæ Volitantes are floating opacities of the vitreous, consisting of filaments, cells, or cell-débris derived from that structure, which are not unfrequently observed by those who are short-sighted, or who strain their eyes by fine work: they frequently persist for years, causing annoyance by their presence, but being productive of no further evil consequences. The only *treatment* to be recommended is the administration of tonics to improve the general health, with rest for the eyes, and the use of dark glasses.

Hemorrhage into the Vitreous is a much more serious affair than hemorrhage into the aqueous humor. In the former situation, absorption takes place very slowly, and shreds of clot are apt to be left, which permanently interfere with vision. The *treatment* consists in local depletion, the application of cold, etc.

Synchisis is a term used to denote a softened and fluid condition of the vitreous. In some cases, the vitreous holds in suspension numerous scales of cholestearine, with, according to Poncet, tyrosine and crystallized phosphates, giving a sparkling appearance when examined with the ophthalmoscope; the condition is then called *synchisis scintillans.* Fluid vitreous may result from injuries, or from various non-traumatic inflammatory affections of the eye; it usually causes diminished tension of the eyeball, though it may be met with in cases of glaucoma. The condition is, I believe, irremediable.

Inflammation of the Vitreous (*Hyalitis*) is a condition the possibility of the existence of which is denied by Pagenstecher; Spencer Watson has, however, recorded an instance of its occurrence, in which a cure was effected by the administration of mercury and the local use of atropia.

Changes in the Choroid.—*Choroiditis* frequently occurs in connection with inflammation of the iris and retina. The changes revealed by the ophthalmoscope may consist merely of increased vascularity, of cloudiness due to serous effusion, or of yellowish-white patches of lymph, often surrounded by pigment, and perhaps traversed by the retinal vessels. Choroiditis is frequently an accident of constitutional syphilis, in which case it is said that the lymphy patches are more circumscribed than in the simple variety of the affection. Bull, of New York, has observed that irido-choroiditis often follows neuralgia of the trigeminal nerve. The *treatment* consists in the cautious administration of mercury, or iodide of potassium, with tonics, especially iron and quinia.

Atrophy of the Choroid, commonly of a local character, usually accompanies posterior staphyloma, in severe cases of myopia. In an advanced stage of atrophy, the choroid is entirely deficient in parts, the exposed sclerotic appearing in its place in the form of white patches. The *treatment* consists in the enforcement of rest to the eyes, with local depletion and counter-irritation. If the disease be rapidly progressive, Lawson advises the administration of the bichloride of mercury.

Anæmia of the Choroid is characterized by paleness of the fundus oculi, and is often accompanied by contraction of the retinal vessels.

Bony Deposits are occasionally found in the choroid, apparently resulting from osseous change in previously formed inflammatory lymph; calcareous deposits are in the same cases often found in the lens and cornea.

Tubercles of the Choroid are met with in cases of acute tuberculosis; the coexistence of the choroidal affection with tuberculosis of the lungs is, according to Steffen, more constant than with the same condition of the pia mater.

Tumors of the Choroid.—The morbid growths met with in this situation belong either to the group which Virchow designates as *sarcomata* (see page 492), or to the *medullary* form of cancer. In either case the tumor is apt to contain a certain amount of *melanotic* deposit. The only *treatment* to be recommended is excision of the globe, which should, if possible, be performed before the tumor has made its way through the external coats of the eye. Wilson, of Dublin, records a case in which a cyst containing crystals of cholestearine was developed between the choroid and retina, simulating glioma of the latter structure.

Changes in the Retina.—*Hyperæmia of the Retina* may be due to overexertion of the eyes, in which case its treatment consists in rest of the organ, and in the use of local depletion, counter-irritation, and the cold douche, with the administration of tonics, etc. In other cases there is a passive venous congestion, due to cerebral disease or the pressure of a tumor. The iodide and bromide of potassium are recommended under such circumstances, but the results of treatment are far from satisfactory.

Retinitis is very often associated with choroiditis, and not unfrequently with iritis. It is marked in its early stages by increased vascularity, and subsequently by the occurrence of extravasation, serous effusion, or lymphy deposit. It is often due to syphilitic or nephritic disease, particularly the former (see p. 457). Mercury, which is serviceable in the syphilitic variety, is totally contra-indicated in that which depends on kidney disease, the most useful remedy in the latter form of the affection being probably the muriated tincture of iron.

Retinitis Pigmentosa (which, from night-blindness being one of its prominent symptoms, is also called *Retinitis Hemeralopica*) is characterized by the deposit of pigment matter on the retina; the disease is incurable, going on to the production of total blindness, though, as the course of the affection is very slow, old age may be attained before this consummation is reached. Prof. Arlt, of Vienna, has given the name *Retinitis Nyctalopica* to certain cases of inflammation of the retina in which the opposite condition is present, the patients seeing better in the dusk than in a bright light; the treatment which he recommends is functional rest, with the use of colored glasses and the administration of mercury.

Apoplexy of the Retina may occur in any of the forms of retinitis (more particularly in the nephritic), or may result from other causes, such as heart disease, atheroma of the retinal vessels, embolism, or suppressed menstruation. The *treatment* consists in obviating a recurrence of the hemorrhage by endeavoring to remove the cause, if this can be ascertained. Advantage may perhaps be derived from the use of iodide of potassium in hastening the absorption of the effused clots.

Anæmia of the Retina may accompany anæmia of the choroid. Such a condition, when met with in cases of epileptiform convulsions, has been called by Hughlings Jackson *Epilepsy of the Retina*. Raynaud has observed anæmia of the retina causing amblyopia, increased by external heat and diminished by cold.

Detachment of the Retina may occur in cases of extreme posterior staphyloma, or may be due to loss of vitreous, to hemorrhage or serous effusion, or to the growth of tumors of the choroid. When the detachment is caused by sub-retinal effusion, an attempt may be made to evacuate the fluid by puncturing the retina with one or two needles, passed through the sclerotic and vitreous, as advised by Von Graefe and Bowman; or with a delicate trocar, as recommended by Wecker; or by puncturing the choroid from without, as suggested by Laurence. Wecker has recently suggested drainage of the sub-retinal space by the introduction of a gold or catgut thread, while McKeown, of Belfast, has successfully operated by excising sub-conjunctivally a portion of both sclerotic and choroid. Dianoux and Green have derived advantage from hypodermic injections of pilocarpine. Martin, Wecker, and Abadie employ galvano-puncture, believing that by exciting a slight degree of choroido-retinitis the increase of retinal detachment may be prevented.

Fatty Degeneration of the Retina sometimes occurs in cases of albuminuria.

Embolism of the Central Artery of the Retina produces contraction of both sets of retinal vessels, but particularly of the arteries, and is often accompanied with sub-retinal effusion in the neighborhood of the macula lutea. Embolism of the retinal artery often depends upon the existence of cardiac valvular disease of the left side. It produces sudden and total blindness, and is rarely recovered from.[1]

Tumors of the Retina.—*Cystic degeneration* of the retina is occasionally observed in an eye which has long been blind, and may require excision of the globe, if the disease should produce pain and threaten the integrity of the other eye. The most common retinal tumor, however, is the *Glioma*, which runs an almost malignant course, and was indeed formerly considered to be of an encephaloid character. The only *treatment* to be recommended is early excision, which may be required in the case of both eyes, if both be affected. The disease often recurs in the orbit.

Changes in the Optic Papilla. *Optic Neuritis.*—Two forms are recognized—one confined to the optic nerve, and the other likewise involving the retina (*neuro-retinitis*). The former is often an attendant upon cranial or cerebral disease (*descending optic neuritis*), while the latter is frequently of a syphilitic nature. In some cases the optic disk is first affected, the disease subsequently extending upwards (*engorged papilla, choked disk, ischæmia*, or *ascending neuritis*). The optic papilla is at first swollen and congested, afterwards assuming a peculiar "woolly" appearance. In *ischæmia* or *choked disk* vision may be retained until a late period of the affection, but in *descending neuritis* it is impaired from the beginning. According to Higgens, and some others, *choked disk* is at first merely a passive, non-inflammatory condition due to intracranial pressure. The *prognosis* is unfavorable, and the *treatment* usually unsatisfactory; mercury, cautiously administered, with the iodide and bromide of potassium, are the remedies commonly employed. Neurotomy, or *slitting the sheath of the optic nerve*, has been advantageously resorted to by Wecker and Power.

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[1] According to Loring, Magnus, and Zehender, many cases of sudden blindness which are ordinarily attributed to embolism are really due to other conditions, such as hemorrhage or serous effusion within the sheath or amid the fibres of the optic nerve.

Excavation, or Cupping of the Optic Papilla.—A slight depression in the centre of the optic disk may exist in the normal state, constituting what is known as the *physiological cup.* In *glaucoma*, and in some cases of advanced myopia, a much more marked and *abrupt* form of cupping is observed; the most distinctive characteristic of this condition is the bending of the retinal vessels at the margin of the optic disk, the whole of which is occupied by the *glaucomatous cup;* if the excavation be very deep, the retinal and papillary portions of the vessels may be seemingly quite disconnected. A *third* form of cupping often accompanies *atrophy of the optic nerve*, a condition which may result from the pressure of intra-orbital tumors, from disease of the brain or spinal cord, or from the abuse of tobacco, etc.

Tumors of the Optic Nerve.—Various forms of morbid growth are met with in this situation, as the fibrous, fibro-cellular, cystic, and cancerous; there are usually in these cases double vision and protrusion of the eyeball, with diminution of the field of vision, or amblyopia; the *treatment* consists in removal of the tumor, which Knapp has succeeded in effecting in one case without removal of the eyeball.

Amaurosis and Amblyopia from Extra-Ocular Causes.—Impairment or loss of vision, without any recognizable primary lesion of the eye, may result from disease of the cerebrum, cerebellum, or spinal cord; from sudden suppression of the menses, or other uterine disturbance (even from pregnancy); from profuse hemorrhage; from reflex irritation, as from a carious tooth; from compression of the optic nerve; from embolism; from the toxic influence of tobacco, alcohol, lead, or quinia; from uræmic poisoning, diabetes, etc. In all cases the *immediate cause* of the loss of sight is interference with the circulation of the nervous structures concerned in vision, or, in permanent cases, atrophy of the optic nerve. A symptom which by some authors is considered of value, in the diagnosis between amaurosis from cerebral and that from spinal disease, is that, in the former, *both* eyes are usually affected, and the pupils dilated; while in the latter, *one* eye only is commonly involved, and the pupil contracted.

The *field of vision* is differently affected in different cases; thus the *centre*, or the *periphery*, of the field may be chiefly involved, or the loss of sight may involve just half of the field (*hemiopia*), vision being perfect on one side of a vertical line, and absent on the other. I have seen a well-marked case of *hemiopia* following a fracture of the base of the skull.

The *treatment* of these forms of amaurosis consists in endeavoring to remove the cause, when that can be ascertained; when resulting from disease of the central nervous system, the prognosis is extremely unfavorable. Nagel, of Tubingen; Chisolm, of Baltimore; Bull, of New York; and Harlan, of this city, have derived advantage in some of these cases from the use of strychnia. The drug may be administered hypodermically, or, which Chisolm now prefers, may be given by the mouth in quantities varying from $\frac{1}{10}$ to $\frac{1}{4}$ grain daily, in divided doses. Quaglino and Bull speak favorably of the use of bromide of potassium in cases of alcoholic amblyopia. Inhalations of nitrite of amyl have been successfully used by Swanzy.

Hemeralopia, Day-Sight, or Night-Blindness, is a functional condition consisting in a diminished sensibility of the retina, due apparently to excessive exposure of the eyes to light, together with a debilitated and especially a scorbutic condition of the system. It is most common among residents in tropical countries, soldiers and sailors, etc. This affection must not be confounded with *Retinitis Pigmentosa*, in which night-blindness is a frequent symptom; in the true hemeralopia, no morbid changes whatever are revealed by the ophthalmoscope. The *treatment* consists in the administration of tonics, especially cod-liver oil, with the use of dark-colored glasses to protect the eyes. If the disease can be traced to scurvy, or to malarial fever, remedies suitable to those affections must be employed. Instillation of a solution of strychnia (gr. j–f℥j) is recommended by Walker, of Liverpool.

Snow-Blindness is a condition analogous to hemeralopia, resulting from exposure to the dazzling reflection from snow; the eyes should be shielded by colored glasses, and tonics administered if the patient's general condition demand their use.

Nyctalopia. — This rare affection is the reverse of hemeralopia, and consists in a hyperæsthetic state of the central portion of the retina, the peripheral part being anæsthetic. The *treatment* consists in protecting the eyes from light, and in improving the constitutional state of the patient, by the use of tonics, particularly the preparations of zinc and iron.

Color-Blindness, or, as Dixon more accurately terms it, *Acritochromacy*, is a defect of vision in which the power of distinguishing one or more colors is lost. Usually red and green are the two colors which are confused together, but in some cases vision is *achromatic*, all colors alike appearing as white, black, or gray. Color-blindness is usually congenital, but may result from disease; achromatic vision existed, as a temporary condition, in a case of optic neuritis observed by Chisolm. When congenital, the affection is probably incurable.

ACCOMMODATION AND REFRACTION.

Accommodation is the power of self-adjustment which an eye possesses, by means of which objects at various distances are equally well seen. This adjustment is accomplished by a muscular effort (on the part of the ciliary muscle), of which the individual is, however, usually unconscious.

Refraction is the passive power by which, when the eye is at rest, rays of light are brought to a focus in the retina; it is a purely physical property, depending upon the shape of the eye and of its various refracting media, as the cornea, lens, etc.

The various anomalies of refraction and defects of accommodation, to which the human eye is subject, have received of late years a great deal of attention from ophthalmologists, and the means by which these anomalies and defects may be recognized and corrected have been thoroughly studied and systematized; for information on these topics, I must, however, refer the student to special treatises on the subject, contenting myself with mentioning and explaining the principal terms employed.

Emmetropia.—This is the normal condition; an eye is *emmetropic*, when parallel rays are converged to a focus on the retina by the refractive power of the eye itself, without any effort of accommodation.

Myopia or Brachymetropia (*Short Sight*).—In this condition, distant rays are brought to a focus *in front of the retina*, the image formed upon which is therefore indistinct. Myopia is usually due to an elongation of the antero-posterior diameter of the eye, and commonly results from a prolongation of the posterior half of the eye, often accompanied with thinning of the sclerotic and partial atrophy of the choroid, constituting posterior staphyloma.

This condition requires the use of *concave* glasses. As spasm of the ciliary muscle is present in many cases, the methodical use of atropia is recommended by Schiess, Windsor, and Derby.

Hypermetropia or Hyperopia is a condition exactly the reverse of the preceding; here, distinct rays come to a focus *behind* the retina, the image on the latter being of course indistinct as in the previous case. A hypermetropic is usually smaller than an emmetropic eye, particularly in its antero-posterior diameter, whence it has a flattened appearance. According to Stevens, of Albany, hypermetropia is often associated with nervous disorders, particularly chorea and epilepsy. Hypermetropia requires the use of *convex* glasses. The local use of Calabar bean is recommended by Magnus.

Ametropia[1] is a general term embracing both the preceding conditions; it is therefore the opposite of *emmetropia.*

Astigmatism is a condition in which the refracting power varies in different meridians of the eye. Thus one meridian may be emmetropic, and others ametropic; or there may be myopia in one meridian, and hypermetropia in another. Many persons have slightly astigmatic vision without knowing it, and it is only when the want of symmetry is marked that the affection excites attention: the remedy is the use of cylindrical glasses.

Aphakia is an anomalous state of refraction caused by the absence of the crystalline lens, as after cataract operations. Aphakia renders the normal eye markedly hypermetropic, while it diminishes myopia, and may even make a myopic eye emmetropic. The remedy for aphakia (which is accompanied with loss of *accommodation*) is the use of powerful convex lenses.

Presbyopia is a diminution of the range of accommodation, interfering with vision of near objects, while distant vision remains unimpaired. Presbyopia is an almost constant attendant upon old age, and can scarcely be looked upon as abnormal: the *treatment* consists in the use of convex glasses.

Paralysis, and Spasm of the Ciliary Muscles may each be a cause of loss of accommodation. The *Calabar bean* may be used for the former, and *atropia* for the latter, condition.

Asthenopia, or *Weak Sight,* may depend upon exhaustion of the power of accommodation in cases of hypermetropia, or upon insufficiency of the internal recti muscles, by which the necessary convergence of the eyes for near vision cannot be long maintained. The former (which is called *accommodative asthenopia*) requires the use of convex glasses, while the latter (*muscular asthenopia*) may demand division of one or both *external* recti, or the use of appropriate prisms. As pointed out by S. W. Mitchell, Higgens, Carter, Piorry, and other writers, asthenopia may give rise to cerebral symptoms, such as headache, giddiness, etc., and may thus be mistaken for intracranial disease.

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[1] For a convenient mode of determining the *degree of ametropia*, see an able paper by Dr. W. Thomson, in the *American Journal of Medical Sciences*, for October, 1870. Dr. Thomson has invented an ingenious instrument, which he calls an *ametrometer*, for measuring the refraction of the eye without the use of lenses.

GLAUCOMA.

Glaucoma is the term which was formerly applied to all cases of impaired vision accompanied by a greenish hue of the pupil, and not manifestly due to lesions situated in front of the iris. The affection was variously supposed to consist in an abnormal condition of the vitreous, retina, optic nerve, or choroid, but its pathology was not well understood until quite recently, and in a great degree through the labors of Von Graefe, who has shown that all the symptoms of this formidable disease are due to an increased intra-ocular tension, caused by the augmented volume of the vitreous and aqueous humors, and probably originating in an irido-choroiditis.[1]

The distinctive *Symptoms* of glaucoma are increased hardness or tension of the eyeball; diminished sensibility, and, at a later period, haziness of the cornea; distension of the ciliary vessels; diminution in the size of the anterior chamber; sluggishness and dilatation of the pupil (which has a green hue); partial atrophy of the iris; and lastly opacity of the crystalline lens. By the ophthalmoscope, the retinal arteries are seen to pulsate; the optic papilla presents the characteristic glaucomatous cup (page 693); the vitreous appears cloudy; and hemorrhages into the deep structures of the eye may be observed. Vision is hypermetropic and presbyopic; the field of vision becomes contracted; amblyopia, at first periodic, ends in complete amaurosis; halos or prismatic spectra are seen on looking at the flame of a candle; and pain, more or less intense, is felt in the eyeball, and along the course of the optic nerve.

Glaucoma is usually met with in persons past the middle period of life, and may arise spontaneously, or as the result of some injury or antecedent inflammation. It is said to be occasionally traceable to the shock of mental or moral emotions. Various forms of the disease are recognized by systematic writers, as the *glaucoma fulminans*, in which the symptoms may be fully developed in a few days or even hours, the acute, the subacute, the chronic or simple, and the consecutive or secondary, the latter being often of traumatic origin.

The *Treatment* of glaucoma consists essentially in the adoption of means to lessen the intra-ocular tension. In mild cases, advantage may no doubt be derived from the assiduous use of atropia or eserine,[2] and of constitutional remedies, but in the majority of instances, no time should be lost in resorting to *iridectomy*, which, under these circumstances, should be performed as directed at page 677. The benefits to be expected from this operation, for the introduction of which we are indebted to Von Graefe, are in inverse proportion to the duration of the disease; thus, if performed during the forming stage of the affection, a perfect cure may be reasonably hoped for; an early operation, even in fully developed acute glaucoma, will probably at least arrest the course of the disease, and prevent further deterioration of sight; while in chronic glaucoma, the structural changes are usually so far advanced before the nature of the case is recognized, that comparatively little can be expected from any mode of treatment.

Other operations for the relief of glaucoma have been practised, and with alleged good results. Thus repeated *paracentesis of the cornea* is highly recommended by Sperino, *trephining of the cornea* by Dr. Argyll Robertson, the use of a catgut or metallic *seton* by Wecker, *cylicotomy*, or division of the ciliary muscle, by Hancock, and puncture or incision of the sclerotic (*sclerotomy*) by Quaglino, Wecker, Lefort, Spencer, Watson, Bader, and Mauthner. The weight of testimony in favor of *iridectomy* is, however, such that the surgeon will usually hesitate to delay the latter operation while experimenting with any other mode of treatment.

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[1] Jonathan Hutchinson, however, has advanced the view that glaucoma is a neurosis, and that the tension of the eyeball is due to tonic contraction of the sclerotic.

[2] Greenway, of Plymouth, advises the application of ice.

AFFECTIONS OF THE ENTIRE EYEBALL.

Ophthalmitis, or *Inflammation of the Eyeball,* may result from traumatic causes, may be idiopathic, or may be an incident of pyæmia, etc. The symptoms are those of deep-seated inflammation generally, with such special phenomena as are traceable to the implication of the various ocular tissues. The disease usually terminates in suppuration and rupture of the globe, or in sloughing of the cornea. The *treatment* during the early stages consists in the use of cold applications, with local depletion, scarification of the conjunctiva, and the instillation of atropia. If there be much tension, the cornea may be tapped with advantage. Spencer Watson recommends, under the name of *keratectomy,* the establishment of a corneal fistula. When suppuration has occurred, warm should be substituted for cold applications, and a free incision should be made as soon as fluctuation reveals the presence of pus. If the eyeball be totally disorganized, excision may be required.

Sympathetic Ophthalmia, or the secondary implication of one eye as the result of disease or injury of the other, is especially apt to occur in consequence of wounds involving the ciliary region, particularly if complicated by the presence of a foreign body. According to C. Higgens, it often follows the operation of sclerotomy. Sympathetic ophthalmia is usually developed five or six weeks after the reception of an injury, though sometimes not until a much later period. In its common form it appears as a severe irido-cyclitis, though it also occurs as a serous iritis, or as a retino-choroiditis. In some cases the sympathetic irritation, though so great as to render the eye practically useless, does not reach the point of structural change, constituting then what Donders describes as *Sympathetic Neurosis.*

The *treatment* of sympathetic ophthalmia, as regards the *eye originally affected,* depends upon the stage of the disease, and the amount of vision possessed by the injured organ. Foreign bodies should be extracted before the development of any sympathetic symptoms, and if the lesion of the eye be so great as to render it useless, excision should be unhesitatingly performed. The same operation would, of course, be indicated, should the case be first seen when the second eye is becoming involved. If the injured eye still retains some sight, at the time of the occurrence of sympathetic symptoms, the course to be pursued is more doubtful; for it has sometimes happened, under these circumstances, that the eye first affected has in the end proved more useful than the other. If the case be seen at a very early period, an iridectomy on the *sympathetically affected eye* may occasionally prove serviceable, but in most instances it is better to wait until the subsidence of acute symptoms, and then, if necessary, extract the lens and make an artificial pupil. Sclerotomy is preferred to iridectomy, in these cases, by Mr. Lawson. The *general treatment* of sympathetic ophthalmia consists in the enforcement of functional rest, with the administration of tonics, especially quinia, the cautious use of mercurial inunction, and the free instillation of atropia. Von Graefe has suggested, in some cases, the formation of a seton through the vitreous, as a substitute for enucleation of the injured globe; while, in the comparatively mild cases of sympathetic neurosis, division of the nerves of the cilliary region has been successfully practised by Meyer, Secondi, and Laurence. *Optico-ciliary neurotomy*, or division of the optic as well as of the ciliary nerves, is advised by J. A. White, Noyes, Burnett, and H. W. Williams; Knapp and Roosa, however, condemn the operation, which is in their opinion less safe than enucleation, and which is said to have caused death in three or four cases.

Excision or Enucleation of the Eyeball is thus performed: The patient being fully etherized, the lids are held apart with a stop-speculum, while the surgeon divides the conjunctiva and subjacent fascia with scissors, in a circle as close as possible to the margin of the cornea. The tendons of the ocular muscles are then successively raised upon a strabismus hook and divided, when, the eye being drawn forwards and outwards, the optic nerve can be cut with long and narrow scissors, curved on the flat. The eye being removed, hemorrhage is to be checked by the application of cold, when, if thought proper, the conjunctival wound may be closed with a silk suture. This, however, should not be done when the operation is performed upon an inflamed eye, as a free vent should then be provided for the discharges. The after-dressing consists in the introduction of a piece of sponge or strip of lint within the lids, and the application of a firm bandage. When cicatrization is complete, and all inflammatory symptoms have subsided, an artificial eye may be adapted.

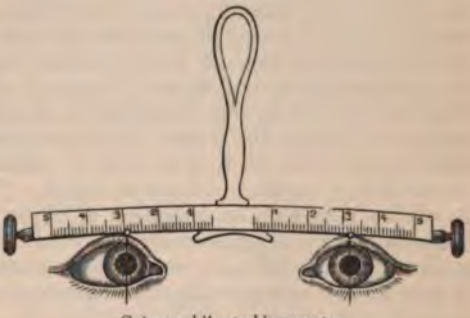
In some cases of malignant disease, it may be necessary to *extirpate the whole contents of the orbit*. This may be done by dividing the external commissure of the lids, incising the conjunctiva, severing the levator palpebræ, attachments of the oblique muscles, and all other orbital connections of the eye, and then, drawing the globe inwards, cutting the optic nerve with curved scissors, introduced on the outer side. The lachrymal gland should be also removed, if it be diseased.

STRABISMUS.

Strabismus, or *Squint*, is defined by Donders as a "deviation in the direction of the eyes, in consequence of which the two yellow spots receive images from different objects." When the squinting is constant in one eye, the strabismus is said to be *monocular;* when the patient can use either eye at will, but not simultaneously, it is called *concomitant, alternating*, or *binocular*. Strabismus is usually *convergent* (cross-eyes), or *divergent*—the former being commonly associated with *hypermetropia*, and the latter with *myopia*. Squinting may be *periodic*, or *persistent;* it may be brought on by various forms of reflex irritation, or may depend on some anomaly of refraction, on defective vision in one eye, or on paralysis of some of the nerves which supply the ocular muscles.

Treatment.—If the affection be *periodic*, an attempt may be made to effect a cure by suitable constitutional treatment, by the use of glasses to remedy the defect in refraction, etc. If the strabismus be *persistent*, and not dependent on mechanical causes, such as the contraction of a cicatrix, or the pressure of a tumor, an operation may be resorted to, one or both internal or external recti muscles being divided, according to the nature and extent of the squint. Before having recourse to an operation, the surgeon should (in a case of concomitant squint) determine which eye is primarily affected, and the degree of convergence or divergence, as the case may be; the former point may conveniently be ascertained by repeatedly causing the patient to close both eyes and suddenly open them, that eye which constantly or habitually deviates from the straight position being the one primarily affected. The degree of squinting can be best ascertained by using the strabismometer devised by Laurence, or that of Galezowski; but in the absence of these instruments, may be simply determined by marking on the lower lid points corresponding to the centre of the pupil, when the eye is fixed, and when it is squinting. If the degree of strabismus be moderate, less than three lines for instance, the primarily affected eye alone need be submitted to operation; but in cases of greater deviation, a better result will be obtained by dividing the operation between both eyes. The object to be accomplished, in an operation for strabismus, is to alter the point of attachment of the divided tendon, and thus diminish the range of motion which it can impart to the eye; hence the importance of ascertaining the degree of deviation, that the separation of the tendon from its attachment may be more or less complete, according to the exigencies of the particular case.

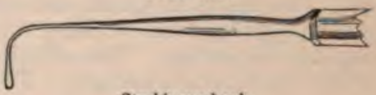
FIG. 364.



Galezowski's strabismometer.

The operation for *Division of the Internal Rectus Tendon* is thus performed: The eyelids being separated with a stop-speculum, the surgeon catches with fine-toothed forceps a fold of the conjunctiva and subjacent fascia, on a level with the lower border of the tendon, and with delicate probe-pointed scissors makes an opening just large enough to admit the strabismus hook; the latter is then insinuated behind the tendon, which it renders tense by drawing it forwards and outwards; the scissors are next introduced closed, and then opened, so as to place one blade behind, and the latter in front of the tendon, which is subsequently divided sub-conjunctivally, close to its sclerotic attachment, by a number of slight cuts. To prevent the slipping of the tendon, which is apt to occur with the ordinary strabismus hook, an ingenious instrument known as the "crotchet hook" has been recently introduced by Dr. Theobald, of Baltimore. A counter-opening in the conjunctiva, to allow the escape of blood, may be made, as is done by Bowman, by cutting with the scissors on the point of the hook before this is withdrawn. The above is known as the sub-conjunctival operation, and was introduced by Critchett. Other surgeons prefer to divide the conjunctiva more freely, afterwards bringing the edges of the wound together with a suture. The surgeon can regulate the effect of the operation by separating more or less freely the sub-conjunctival fascia from the tendon to be divided, thus allowing the greater or less retraction of the latter. The application of a suture also serves to lessen the effect of the operation. Snellen makes the conjunctival incision in a direction parallel to and immediately over the muscle, which he then seizes with forceps and divides with sharp-pointed scissors. Dr. Frank, of Baltimore, effects the division of the tendon with an instrument similar to the knife-hook used by Purves in cases of aural polypi.

FIG. 365.



Strabismus hook.

The *External Rectus Tendon* may be divided by an operation analogous to that above described. Considerable difference of opinion exists among surgeons as to whether both eyes should be operated on simultaneously (when both require operation), or whether the second operation should be postponed until after an interval of several days. Probably a safe rule is that given by Wells, to wait and observe the effect of the first operation, in cases of deviation of less than five lines; by this precaution the surgeon can form an estimate as to how much remains to be accomplished in the second operation. In cases in which, by too free division of the internal recti muscles, a convergent has been converted into a divergent squint, it may be necessary to divide the new attachments of one or both tendons, and bring them forward to insert them nearer the cornea,[1] holding them in place with fine sutures, and thus reversing the effect of the original operation. A similar procedure is sometimes employed in cases of *paralytic strabismus*, in the treatment of which R. B. Carter has also resorted to localized faradization. *Anæsthesia* is, as a rule, undesirable in squint operations, though it may be employed in cases of children, or in those of nervous adults. The *after-treatment* in cases of strabismus consists (if both eyes have been operated on) in simply bathing the parts with cold water; if *one* eye only has been submitted to operation, the *other* should be closed with a bandage, so as to force the patient to use that of which the tendon has been divided. Advantage may often be subsequently derived from the use of suitably adjusted prismatic glasses, so as gradually to restore binocular vision. These glasses may, indeed, suffice to effect a cure without operation, in slight cases of *periodic squint*.

Instead of *dividing the contracted tendon* in cases of strabismus, Dr. Noyes advises that the *opposing or elongated tendon should be shortened*, by cutting it near its insertion into the eyeball, bringing the posterior under the anterior portion, and securing it there with sutures.

Diseases of the Eyelids.

Ophthalmia Tarsi (*Tinea Tarsi, Blepharitis ciliaris*) is the name given to a subacute or chronic form of inflammation, affecting the edges of the eyelids and the follicles of the lashes, which become loosened and fall out. The palpebral edges are red, thickened, and sometimes ulcerated, and become glued together by the drying of the accumulating secretion. In its severer forms, the affection gives rise to the condition known as *Lippitudo* or *Blear-eye*. The *puncta lacrymalia* are often everted or obliterated, giving rise to a constant stillicidium of tears, which excoriate the skin and add to the patient's discomfort. This affection is, according to Roosa, often dependent on the existence of *ametropia*. The *treatment* consists in removing the dried secretion by warm fomentations, and smearing the edges of the lids with dilute citrine ointment.[2] In severer cases the local application of nitrate of silver will be of service, and, if the puncta be everted or obliterated, the canaliculi should be freely slit up, the incision being directed inwards. As this affection commonly occurs in scrofulous children, cod-liver oil may be properly administered in most cases. If the patient be ametropic, relief may be afforded by the installation of atropia and the use of suitable glasses. Oliver recommends tattooing the edges of the lids with India ink, as a cosmetic remedy in inveterate cases.

Hordeolum or Stye is a small boil occurring at the edge of the lid, and often originating in the follicle of an eyelash; it is met with usually in debilitated persons, and occasionally as the result of over-exertion of the eyes, or of exposure to too bright a light, as to the glare reflected from snow.

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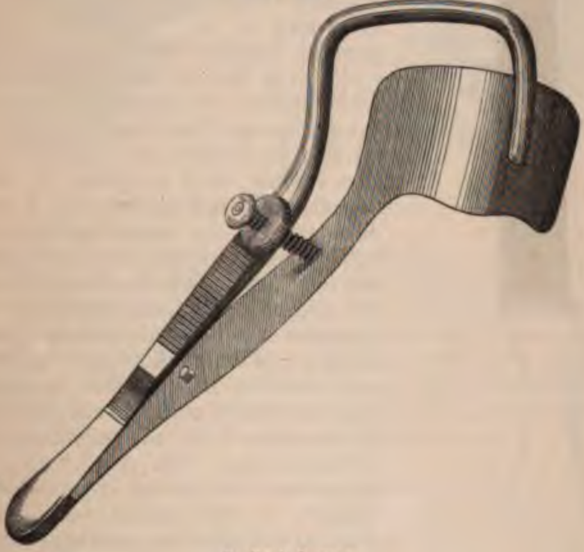
[1] An ingenious method of doing this is described by C. R. Agnew, in *Trans. N. Y. State Medical Society* for 1871.

[2] Ung. hydrargyri nitrat. ʒj; Ung. aq. rosæ ʒvij. M.

When situated just within the edge of the lid, it produces pain by pressing on the globe; relief may be sometimes afforded under these circumstances by fixing the lid in a position of slight eversion by means of collodion. The *treatment* consists in the use of warm fomentations, with a puncture if required, the induration which remains being dispersed by the use of dilute citrine ointment. Tonics are usually indicated as constitutional remedies.

Trichiasis and Distichiasis.—The former term signifies an irregular displacement of the eyelashes, some of which, stunted and inverted, produce great irritation by friction on the conjunctiva and cornea, the latter becoming in extreme cases cloudy and vascular. In *distichiasis* a complete double row of lashes exists, the inner row being inverted, and producing great irritation as in the previous case. The *treatment* of either affection consists in carefully extracting with cilia forceps the offending lashes, or, in severe cases (if the upper lid be involved), excising the whole row of cilia, by means of two incisions parallel to the lashes and one on either side, the tarsal cartilage being thus split, and a wedge-shaped strip bearing the cilia removed. The operation may be facilitated by first fixing the lid with Snellen's forceps.

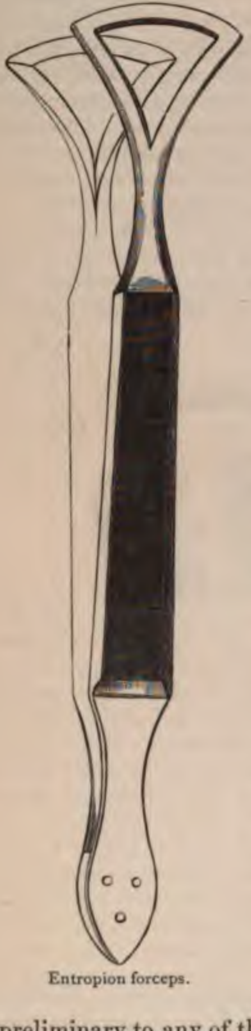
FIG. 366.



Snellen's forceps.

Herzenstein applies a subcutaneous ligature around the roots of the lashes, while Hayes, of Dublin, induces sloughing of the follicles by the hypodermic injection of the perchloride of iron. If but one or two lashes are involved, an old operation revived by Snellen, Watson, and Robertson, may be resorted to. This consists in drawing the displaced eyelash, by means of a fine ligature (Watson employs human hair) under the skin of the eyelid, and thus mechanically altering the direction of the lash's growth. For complete distichiasis, Watson employs transplantation, as practised by Arlt in cases of entropion. In the case of the lower lid, it will usually be sufficient to remove an elliptical strip of skin with the subjacent fibres of the orbicularis muscle, thus producing eversion as in the operation for *entropion*.

Fig. 367.



Entropion forceps.

Entropion, or *Inversion of the Lids,* may result simply from spasmodic action of the orbicularis palpebrarum (*blepharospasm*), as in the entropion after cataract operations in old persons, or from long-continued conjunctival inflammation, the injudicious use of caustics, etc. The irritation produced by the friction of the inverted lashes is very great, and sometimes induces opacity of the cornea. The *treatment* of the spasmodic cases[1] consists in restoring the lid to its proper position by traction with the fingers, and then fixing it by the application of collodion, the contractile property of which serves to obviate the tendency to inversion. Chronic cases of entropion may be remedied by various operations, such as (1) pinching up, with entropion forceps, and excising a small strip of skin with the subjacent fibres of the orbicular muscle, parallel to the ciliary border of the lid—the wound being subsequently closed or not with sutures;[2] (2) "grooving the tarsal cartilage," as recommended by Streatfeild, the operation consisting in the removal of a transverse strip of the cartilage by means of two parallel incisions meeting at the apex of a V—the skin wound being subsequently closed with stitches; (3) excising a narrow oval piece extending the whole length of the cartilage, as advised by Berlin; (4) making a linear incision, cutting away a portion of the orbicular muscle, and stitching the skin of the lid to the distal edge of the tarsal cartilage, as practised by Hotz, of Chicago; (5) the introduction of two or three threads in a longitudinal direction through the cutaneous surface of the lid, the ligatures embracing the ciliary margin and being allowed to cut their way out by ulceration, as advised by Pagenstecher, or embracing the skin and muscle of the lid only, as recommended by Laurence;[3] (6) the excision of a triangular portion of skin, with or without a part of the subjacent cartilage, as recommended by Von Graefe; (7) the removal of the whole row of cilia, as described in speaking of trichiasis; or (8) transplantation of the cilia to a better position on the lid, as practised in various ways by Arlt, Fæsche, Warlomont, and McKeown. As a preliminary to any of these operations, it will often be advisable to slit up the external canthus (*canthoplasty*), re-adhesion being prevented by uniting the skin and mucous membrane on either side with a stitch.

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[1] Dr. Harlan reports an obstinate case of blepharospasm cured by inhalations of nitrite of amyl.

[2] Schneller has modified this operation by circumscribing, without excising, an elliptical strip of skin, and having loosened the lateral portions, uniting them with sutures above the central portion, which is thus covered in and serves as a splint to give firmness to the part.

[3] A somewhat similar operation is employed by Solomon, and is said to have been devised by Snellen, of Utrecht.

Ectropion, or *Eversion of the Lids,* may be of an *acute* character, resulting from spasm of the inner fibres of the orbicularis palpebrarum in cases of purulent conjunctivitis, in which case its treatment is that of the disease which it accompanies, or may appear as a *chronic* affection, resulting from ophthalmia tarsi, chronic conjunctivitis, etc. Under these circumstances, the treatment consists in the application of nitrate of silver to the mucous membrane just within the line of eversion, with slitting of the canaliculi if the puncta be everted or occluded. Ectropion from the contraction of *cicatrices, abscesses,* etc., usually requires an operation,[1] which may consist (1) in excising a portion of the everted conjunctiva; (2) in removing a triangular-shaped piece of all the tissues of the lid near the external canthus, and bringing the edges of the wound together with harelip pins, thus shortening the lid (Figs. 368, 369); (3) in making a transverse incision through the lid down to the conjunctiva, drawing this through the wound to the requisite extent, and cutting it off with scissors; or (4) in dissecting out the vicious cicatrix and filling the gap by transplanting a flap of skin, from the forehead in case of the upper, and from the nose or cheek in case of the lower, lid, or even, as successfully practised by Wolfe, Wadsworth, Von Zehender, Aub, Reeve, Abbott, Noyes, Mathewson, Ely, E. Smith, Tosswill, and other surgeons, from a distant part, the flap being shaved down so as to assimilate the operation to Reverdin's plan of transplanting cuticle.

FIG. 368.

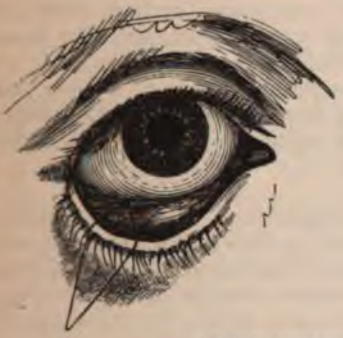
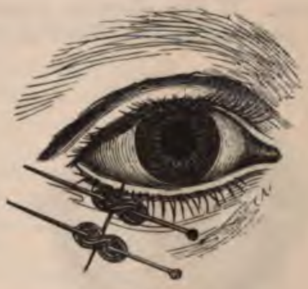


FIG. 369.



Adams's operation for ectropion. (LAWSON.)

Excurvation of the Eyelids is the name used by Laurence for the peculiar deformity observed, particularly in the upper lid, in cases of inveterate trachoma; the remedy, according to this writer, consists simply in dividing the outer canthus, and uniting the cut edges of conjunctiva and skin by stitches above and below.

Ptosis, or *Falling of the Upper Lid,* may be congenital, or may result from the increased weight of the part due to inflammatory thickening, from wounds dividing the levator palpebræ or its nerve, or from paralysis of the third nerve. The *treatment* (in cases of sufficient severity to justify operation) consists in removing an elliptical portion of the skin and subjacent muscle of the lid, the edges of the wound being then approximated transversely, so as to place the part under control of the occipito-frontalis muscle, which sends fibres to the upper portion of the orbicularis—or in the introduction of ligatures as described in speaking of entropion. In paralytic cases, the endermic application of strychnia has been occasionally resorted to with advantage. Dr. Van Bidder, of New York, recommends the employment of a delicate India-rubber band, fastened with collodion and isinglass plaster to the edge of the lid and to the forehead, so as to supplement the paralyzed muscle, as in Barwell's and Sayre's method of treating club-foot. Dr. Mathewson has employed a similar plan in the treatment of spasm of the orbicularis (*blepharospasm*). Mr. Hutchinson has described, under the name of *ophthalmoplegia externa*,[1] cases of partial, symmetrical immobility of the eyes, with ptosis, due to syphilis, either congenital or acquired, and susceptible of improvement from the use of iodide of potassium.

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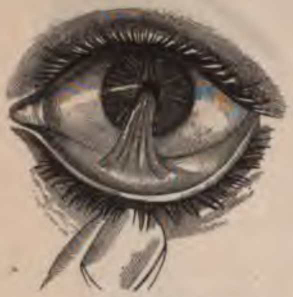
[1] C. S. Bull advises kneading and traction of the cicatrix, as a preliminary to any operation of blepharoplasty.

Lagophthalmos, or *Hare-eye*, denotes an inability to close the eyelids; it may result from the contraction of cicatrices, when its treatment is that directed for ectropion, but more often depends on paralysis of the orbicular muscle from some local affection of the portio dura, or from intra-cranial causes. If the affection appear to result from the pressure of a tumor on the portio dura, the offending growth should, of course, be removed; a blister to the temple may be of service in cases resulting from exposure to cold; while, if a syphilitic origin be suspected, the iodide of potassium should be administered.

FIG. 370.



Symblepharon. (MACKENZIE.)

Symblepharon is a morbid adhesion of the eyelid to the eyeball, resulting usually from the cicatrization of burns, ulcers, etc. The *treatment* consists in (1) dividing the adhesions, and uniting the cut edges of conjunctiva with sutures (Wilde); (2) covering the raw surface, left after severing the adhesions, with flaps of healthy conjunctiva taken from unaffected parts of the eyeball (Teale),[2] or with a flap from the skin of the eyelid itself, passed through a slit in the tarsal cartilage (C. B. Taylor); (3) dissecting back the symblepharon as far as the retro-tarsal fold, doubling it upon itself so as to oppose a mucous surface to the globe, and fixing it in this position by means of a ligature which is armed with two needles and passed through the lid from within outwards (Arlt); or (4) employing delicate flaps taken from the cheek or forehead, and inverted so as to turn the cutaneous surface toward the eyeball, as successfully done by Dr. G. E. Post, of Beirut, Syria. Dr. MacFarlan, of New York, succeeded in one case by simply dissecting out the symblepharon and keeping the lid drawn away from the globe, until cicatrization occurred, by attaching the lid to the cheek with pins and ligatures.

Anchyloblepharon is an abnormal adhesion of the free edges of the upper and lower lids, either congenital or the result of injury, etc. The *treatment* consists in severing the adhesions with a small knife and grooved director, reunion being prevented by touching the cut edges with collodion.

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[1] The same writer applies the name *ophthalmoplegia interna* to cases of paralysis of the internal muscles of the eye, which he believes to be due to disease (probably syphilitic) of the lenticular ganglion.

[2] Wolfe, of Glasgow, Dufour, Calhoun, of Georgia, and M. H. Brown, of New York, have operated successfully by transplanting portions of conjunctiva from *rabbits*.

Epicanthus is a congenital affection in which a crescentic fold of skin overlaps the inner canthus of the eye, producing considerable deformity; the *treatment* consists in excising a longitudinal fold of skin and bringing the edges of the wound together with sutures, so that the subsequent contraction may expose the previously hidden canthus.

Tumors of the Eyelids.—*Sebaceous, Vascular, and other Tumors* occur on the eyelids, and are to be treated as similar growths in other situations. The *Chalazion*, or *common tarsal tumor*, appears to originate in a distended state of a Meibomian follicle, and often suppurates; the *treatment* consists in making an incision on the conjunctival surface and squeezing out the contents of the mass. Chisolm recommends, in all cases of palpebral cyst, simple puncture followed by evacuation of the cyst contents, and subsequent cauterization of the cavity with a silver probe dipped in nitric acid.

Diseases of the Lachrymal Apparatus.

Diseases of the Lachrymal Gland.—This organ may be *inflamed* (*Dacryoadenitis*), or may be the seat of various *morbid growths*. These affections are, however, rare, and their treatment presents no features calling for special comment. *Fistula of the Lachrymal Gland* may result from abscess or wound of this part; it may be treated by paring the edges and introducing a suture, by the application of caustic or the galvanic cautery, or by establishing a free communication with the conjunctival surface by the use of a seton, as has been successfully done by Bowman.

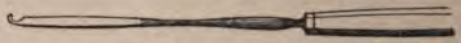
Excision of the Lachrymal Gland is recommended by Laurence in cases of obstruction of the canaliculi, in which it is found impossible to restore their permeability; the operation consists in making an incision below the upper and outer third of the orbital ridge, cautiously opening the orbit, seizing the gland with a double hook, and carefully dissecting it from its attachments; hemorrhage having ceased, the wound is closed with sutures. To avoid the risk of ptosis, which occasionally follows the operation, Mr. Laurence suggests that an internal incision should be made through the upper sinus of the palpebral conjunctiva, with an external division of the outer canthus; the substance of the lid would not thus be involved in the operation.

Xerophthalmia, or *Dryness of the Conjunctiva*, from deficiency of the tears and mucous secretion which naturally lubricate the part, may be greatly alleviated by the local use of glycerine.

Epiphora, strictly speaking, signifies an excessive secretion of tears, but the term is often used as equivalent to *Stillicidium Lacrymarum*, which is the overflow from obstruction of the canaliculi or nasal duct. Excessive lachrymation may be a symptom of various inflammatory conditions of the eye, or may result from the presence of foreign bodies, entropion, etc., under which circumstances its treatment requires, of course, the removal of the cause to which the epiphora is due.

Obstruction of the Canaliculi may occasionally be remedied by dilatation of the passage with probes of gradually increasing size, but it will usually be necessary to slit up the canal with a delicate grooved director and cataract knife, with scissors, or with a delicate beaked knife, which is perhaps the most convenient instrument. The same operation is required in cases of *eversion or obliteration of the puncta lacrymalia.* The lower canaliculus is the one usually slit, the incision being made towards the conjunctival surface, so as to open a passage for the tears. Reunion is to be prevented by the daily introduction of a probe, by the application of nitrate of silver, or by excising a small portion of the mucous membrane. If the punctum be indistinguishable, the lachrymal sac may be opened beneath the *tendo oculi*, and the canaliculus slit from below upwards, as recommended by Bowman, or a bent director may be introduced through the *upper* punctum and brought around into the *lower* canaliculus, or *vice versâ*, as advised by Streatfeild.

FIG. 371.



Bowman's canaliculus knife.

Obstruction of the Nasal Duct usually results from thickening of its mucous lining, as the consequence of chronic inflammation. The *treatment* consists in effecting gradual dilatation by means of probes, introduced through the punctum, the canaliculus being, if necessary, previously slit. In passing probes through the canaliculi and nasal duct, the position of the instrument is at first longitudinal, then transverse, and then somewhat longitudinal again, with a slight inclination inwards and backwards in correspondence with the anatomical disposition of the parts, which must be borne in mind. Metal probes are commonly to be preferred for dilation of the lachrymal passages, though bougies of the *laminaria digitata* have been successfully employed by several surgeons. Other modes of treatment are the introduction of a style through the slit canaliculus into the nasal duct, the instrument being allowed to remain several days (Bowman), the internal division of the strictured part by nicking the seat of obstruction in several directions with a suitable knife (Stilling), and the forcible dilatation or rupture of the stricture, as in Holt's method of treating stricture of the urethra (Hernenstein). The old plan of introducing a style through an external excision, is now generally abandoned.

Inflammation of the Lachrymal Sac may be *acute* (*Dacryo-cystitis*) or *chronic* (*Blennorrhœa, Mucocele*). The former variety of the affection is to be treated with warm fomentations, and an early puncture from the conjunctival surface, if suppuration occur; and the latter by the use of astringent lotions, by slitting the canaliculus and dilating any stricture that may be found, and by washing out the sac with astringent injections introduced by means of a canula and syringe. In obstinate cases it may be necessary to excise the anterior wall of the sac (Von Ammon, Bowman, Lawson, Monoyer), or to obliterate the sac itself by the use of caustic or the galvanic cautery, applied through an incision, which is best made, as advised by Agnew, of New York, through the conjunctiva. Suppuration in the region of the lachrymal sac may, as pointed out by Parinaud, be due to dental disease.

Fistula Lachrymalis, or fistula of the lachrymal sac, may result from either acute or chronic inflammation of the part; the *treatment* consists in the removal of any obstruction to the natural course of the tears, and in the use of astringent injections; if necessary, the sinus may be laid open with a cataract knife, or its edges may be pared and a suture introduced.

Syphilitic Affections of the lachrymal apparatus, both secondary and tertiary, are described by R. W. Taylor, of New York.

DISEASES OF THE ORBIT.

Abscess of the Orbit may be *acute* or *chronic;* the symptoms of the former are those of abscess in general—deep-seated and constantly increasing pain, aggravated by motion or pressure, with a swollen, glazed, and œdematous state of the eyelids (particularly the upper), chemosis of the conjunctiva, and protrusion of the eye, the displacement being usually somewhat downwards and inwards, as well as forwards. Impairment of sight results from pressure on and stretching of the optic nerve. Fluctuation is finally developed, and pointing usually occurs below the inner portion of the supra-orbital ridge. The symptoms of chronic abscess are much less distinctive, the diagnosis from encephaloid or other soft tumor being often impossible without the aid of the exploring needle. The *treatment* of either form of abscess consists in making an incision with a knife introduced flatwise at the point of greatest fluctuation, the subsequent management of the case being conducted on general principles. If a *sinus* persist after the evacuation of an orbital abscess, it may be stimulated to heal by the use of astringent injections.

Periostitis, Caries, and Necrosis of the orbital walls are ocasionally observed, usually as the result of constitutional syphilis. The *treatment* of these affections presents no features requiring special comment.

Tumors of the Orbit.—Various forms of morbid growth are met with in this region, as the cystic, cartilaginous, osseous, fibrous, recurrent, vascular, and cancerous. The *treatment* of these different affections has been sufficiently considered in Chapter XXVI.; in dealing with non-malignant growths, the eyeball should, if uninvolved, be, if possible, allowed to remain; but in the case of cancerous tumors of the orbit, it must commonly be removed, to allow space for complete excision of the morbid growth. Lawson recommends that, after the removal of a malignant tumor from the orbit, lint spread with a paste of chloride of zinc should be carefully applied to the whole surface from which the growth sprang. *Hydatids* of the orbit have been observed by Lawson, Higgens, and others.

Aneurisms of the Orbit.—The orbit may be the seat of ordinary aneurism, affecting the ophthalmic artery, of traumatic aneurism, or of aneurism by anastomosis. In either of the two first-named conditions there would be exophthalmos, with more or less pulsation, but according to Terrier and Rivington, who have ably investigated the literature of the subject, the same symptoms may be equally due to an extra-orbital aneurism of the ophthalmic artery, to an aneurism of the internal carotid, to an extra-orbital aneurismal varix involving the internal carotid and the cavernous sinus, or to dilatation from obstruction of the ophthalmic vein. Aneurism by anastomosis appears to involve the orbit only by spreading from neighboring parts, and is not accompanied by exophthalmos. Vascular protrusion without pulsation may result also from hypertrophy and hyperæmia of the adipose tissue of the orbit, as in the peculiar affection known as *Exophthalmic Goitre*, or *Graves's* or *Basedow's Disease.*[1] The surgical treatment of orbital aneurisms has already been considered. (See pages 539, 569.)

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[1] See an able paper by Dr. T. G. Morton, in *Amer. Journ. of Med. Sciences* for July, 1870.

Distension of the Frontal Sinus, by the accumulation of pent-up fluid, may, by forming a tumor at the upper and inner portion of the orbit, cause displacement of the eyeball, and entail great disfiguration on the patient. The *treatment* consists in evacuating the fluid by perforating the thinned wall of the sinus and then establishing a free communication with the nose, re-accumulation being prevented by the introduction of a drainage-tube.

CHAPTER XXXVI.

DISEASES OF THE EAR.

As in dealing with Diseases of the Eye, it is not my intention in the following pages to discuss all those subjects which properly belong to the domain of *aural surgery*, but to refer only to those more common affections of the ear which the general practitioner may at any time be called upon to treat, and to describe those operations upon the organ of hearing which every surgeon should be competent to perform.

Diseases of the Auricle.

Malformations of the Auricle are occasionally met with, usually in conjunction with other congenital defects; if the malformation consists in *contraction of the orifice* of the meatus, from undue projection of the tragus or antitragus, advantage may be derived from the employment of dilatation, or from excision of a portion of the cartilage. *Congenital closure* of the meatus by an abnormal membrane, may be remedied by an incision and the subsequent use of tents. *Supernumerary auricles* may be treated by excision, as in cases related by Birkett and Gross.

Chronic Inflammation of the auricle, attended with great thickening, induration, itching, and tenderness, is chiefly observed in debilitated women who have passed the middle period of life; it sometimes remains after the subsidence of an attack of erysipelas, and is commonly called *chronic erysipelas* of the ear. The *treatment* consists in the application of nitrate of silver or other astringent lotions, with the administration of tonics, if required. The itching may be relieved by the local use of glycerine or collodion, and a silver tube may be fitted to the meatus, if this be permanently contracted.

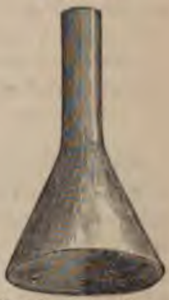
Chronic Eczema is another affection of the auricle which produces much annoyance; during the early stages, soothing applications are required, while at a later period advantage may be derived from the use of astringent lotions, or of slightly stimulating substances such as the dilute citrine ointment.

Tumors of the Auricle.—These may be cystic, fatty, fibrous, vascular, malignant, etc. Those particularly deserving mention are the blood-cyst, *Othæmatoma*, or *Hæmatoma Auris*, frequently observed in the insane, and the fibrous, cheloid-looking growth which occasionally follows the use of ear-rings. The former affection, which, according to Brown-Séquard as quoted by Keller, is due to the existence of a lesion in the left posterior portion of the brain, and may be artificially produced in animals, requires the use of evaporating lotions during the acute stage, followed by the introduction of a seton, or, which Dr. Hearder recommends as producing less deformity, the application of a blistering fluid to the inner surface of the pinna. The cheloid-like growth may be treated by excision, but the disease is apt to return.

DISEASES OF THE EXTERNAL MEATUS.

In some cases it is possible to obtain a satisfactory view of the meatus by simply placing the patient in a good light and drawing the ear slightly backwards and upwards, while the tragus is pressed in the opposite direction; it is usually necessary, however, to employ a *speculum*—the best instruments for general use being, I think, those known as Toynbee's (Fig. 372) and Gruber's, which may be used with either natural or artificial light: in the latter case, a reflector is required, and the same may be employed to utilize diffused daylight, which is usually preferable to the direct rays of the sun. The speculum may be made of polished silver or of vulcanite, the latter being probably the best material for the purpose. For special cases other instruments may be employed, such as Hassenstein's (which is provided with a tube containing a lens and a perforated mirror), the ingenious prism speculum devised by Dr. Blake, of Boston, or the binocular speculum suggested by Dr. Eysell. Dr. Blake also employs small reflectors, which can be introduced through perforations in the *membrana tympani.*

FIG. 372.



Toynbee's speculum.

Accumulations of Cerumen or Ear Wax, mingled with short hairs and flakes of cuticle, are often met with, and are a frequent cause of deafness; the *treatment* consists in the removal of the hardened mass by syringing, as directed for *foreign bodies in the ear* (page 347), subsequent irritation being prevented by the application of a little olive oil or glycerine.

Vegetable Parasites have been met with in the meatus, causing a constant accumulation of dense, white flakes of thickened cuticle; the *treatment* consists in frequent syringing with lead-water or a weak solution of chlorinated lime. Lévi recommends the use of nitrate of silver, followed by a solution of common salt.

Follicular Abscesses occur in the meatus, constituting an extremely painful and annoying affection; they are chiefly met with in those of debilitated constitution, and are said to be common among patients who suffer from styes of the eyelids. The *treatment* consists in the use of hot anodyne poultices or fomentations, irrigation with warm water, and evacuation of the pus as soon as its presence is detected, with the application of dilute citrine ointment to remove any induration which may be left. The preparations of iron may be administered internally, if a tendency to recurrenee be observed. Weber-Liel employs, as an *abortive* measure, interstitial injections of a five per cent. solution of carbolic acid.

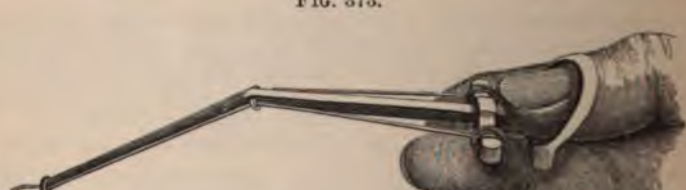
Catarrhal Inflammation of the external meatus, or *Otorrhœa,* is characterized by the presence of a muco-purulent discharge, and is, according to

Hinton, usually accompanied by a similar affection of the tympanic cavity. The *treatment* (as far as the meatus is concerned) consists in syringing to insure cleanliness, followed by the use of astringent lotions or by the insufflation of powdered talc, which is particularly recommended by the above-named author. Dr. T. G. Morton, of this city, has employed with advantage a "styptic cotton," prepared by soaking cotton-wool in a dilute solution of the subsulphate of iron. Insufflation of alum is highly commended by Chisolm. Guyon advises the introduction of a drainage-tube. The administration of tonics is usually indicated by the constitutional condition of the patient. Counter-irritation over the region of the mastoid process may often be advantageously employed.

Chronic Inflammation of the meatus often results in the production of a *thickened state of the epidermis,* with desquamation, and accumulation of flakes of cuticle. These must be removed by syringing, a solution of nitrate of silver, or the dilute citrine ointment, being subsequently applied. Another occasional result of chronic inflammation is the development of a *granular condition* of the lower part of the meatus and membrana tympani, somewhat analogous to granular lids. The *treatment* consists in the use of a solution of nitrate of silver, or in the insufflation of powdered alum or tannic acid. The presence of a *diphtheritic membrane* in the external ear has been noted by Gruber, and by Callan, of New York.

Polypi frequently arise from the deeper portions of the meatus, though, according to Hinton, their more common seat is the inner wall of the tympanum, whence they protrude, distending and finally rupturing the tympanic membrane. Polypi of the ear occur under several forms, but in structure all appear to correspond with the *fibro-cellular* variety of tumor[1] (p. 480). They produce, when large, a feeling of distention and irritation, and are sometimes attended with grave cerebral symptoms. The *treatment,* from whatever position they spring, consists in subduing any existing irritation by the use of lead lotions, counter-irritation, etc., removing the growth, and adopting means to prevent its recurrence. The removal of an aural polypus is usually best effected by means of the "snare" of Sir W. Wilde (Fig. 373), or by delicate forceps, of which two forms are exhibited in the annexed cuts (Figs. 374, 375). Purves, of London, employs an instrument consisting of a hook provided with a cutting edge, which he calls a "polypus knife-hook." The more vascular polypi may be treated by caustic applications, such as the potassa cum calce, introduced through a glass speculum. Politzer and McBride recommend instillations of alcohol. If the *snare* be used, Hinton

FIG. 373.



Wilde's snare.

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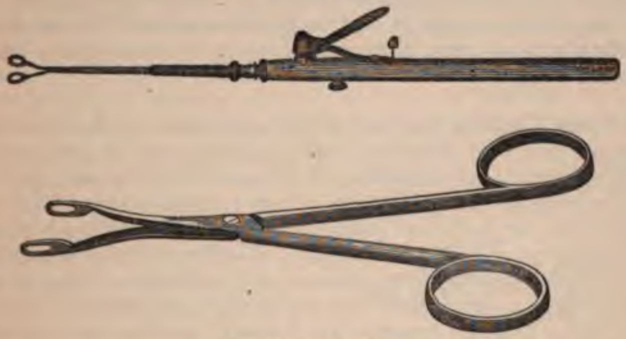
[1] Toynbee describes three varieties, the *raspberry cellular*, the *fibro-cartilaginous*, and the *globular cellular* polypus.

recommends that it should be armed with the gimp employed by anglers instead of wire. After the removal of a polypus, its roots must be treated with caustic applications, such as chromic acid, chloride of zinc, or potassa fusa—astringent lotions being at the same time used, and the Eustachian tube rendered pervious, if occluded. If the membrana tympani be perforated, Hinton's plan of throwing a stream, by the syringe, from the meatus through to the fauces, should also be adopted. When a decided impression has been made upon the root of the polypus, astringents, such as weak solutions of nitrate of silver or lead-water, may be substituted for the caustics, or insufflations of powdered talc or alum may be employed.

Figs. 374, 375.



Forceps for aural polypus.

Tumors of the Meatus.—*Exostoses* and *hyperostoses* are occasionally met with in the walls of the meatus, and, if large, may encroach so much on the canal as to cause deafness. According to Cumberbatch, they are often of gouty origin. The *treatment*, in the early stage, consists in the application of the tincture of iodine to the surface of the growth and behind the ear, and by a perseverance in this plan the increase of the tumor may sometimes be arrested. At a later period, little can be done beyond preventing the accumulation of wax and cuticle by frequent syringing, though Cassells recommends removal with a gouge or drill. Cumberbatch has seen benefit from the application of nitric acid. Bagroff employs the gouge and galvano-cautery. *Sebaceous* or *molluscous* tumors result from the enlargement of sebaceous follicles, and when laid open are found to consist of a cyst-wall containing layers of epidermis. If neglected, they are apt to cause absorption of the bone, and grave or even fatal cerebral complications. The *treatment* consists in laying open the cyst, evacuating its contents by syringing, and then drawing out the cyst-wall with forceps.

Diseases of the Membrana Tympani.

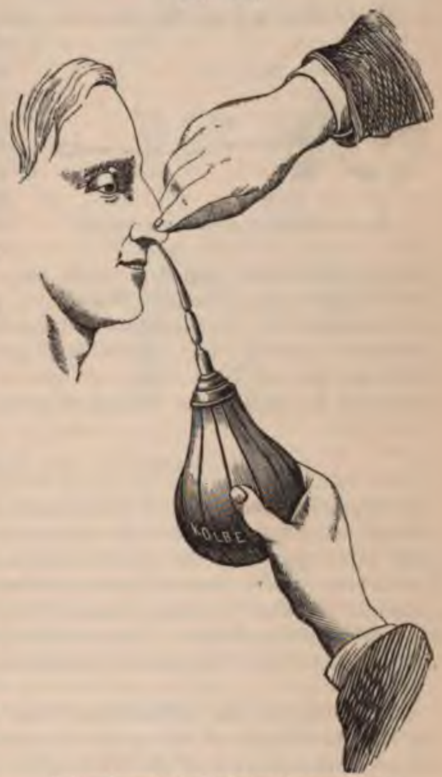
The Dermoid Lamina of the membrana tympani may be the subject of *simple acute*, *chronic*, or *catarrhal* inflammation, these affections often accompanying similar conditions of the external meatus. *Acute* inflammation of the dermoid lamina can usually be made to terminate in resolution, by the use of local depletion, hot fomentations, and frequent syringing with warm water. *Chronic* inflammation often causes an accumulation of epidermis, requiring the employment of the syringe, and perhaps the use of an astringent lotion, with counter-irritation over the region of the mastoid process. The *catarrhal* form of inflammation is of a more serious character, being apt to terminate in the formation of granulations, or even of polypi—or in ulceration, which may extend to the fibrous laminæ. The *treatment* is the same as for the ordinary chronic inflammation. Tonics, especially iron, quinia, and cod-liver oil, are usually indicated by the constitutional condition of the patient. Many of the symptoms of *meningitis* may, according to Bonnafont, be simulated by inflammation of the membrana tympani, or by compression of this organ by accumulated cerumen or by intra-tympanic mucus; the diagnosis may, however, be made by observing that in these affections the mental faculties are not involved.

The Fibrous Laminæ are also subject to inflammation of an acute or chronic character, very often associated with a gouty or rheumatic state of the system. *Chronic* inflammation often leads to a *dense and rigid* condition of the membrane of the tympanum, which may be recognized through the speculum when air is forced into the tympanic cavity, and which is not usually accompanied with pain, but with an annoying *tinnitus*, or ringing in the ears, and with deafness—the latter symptom, however, being in all probability due rather to the state of the tympanic cavity itself, than to that of its membrane. Toynbee recommends for this *rigidity of the membrana tympani*, the application of nitrate of silver (℈ss–j to f℥j), and Hinton speaks highly of a combination of ether or tincture of camphor with opium and glycerine, as a means of relieving the tinnitus, when all inflammatory symptoms have subsided. Section of the tensor tympani muscle has been advantageously resorted to in some cases by Weber, and by Turnbull, of this city. In the opposite condition, viz., *relaxation of the membrana tympani* (which may result from inflammation, or from simple atrophy), temporary benefit may often be derived from inflating the cavity of the tympanum; and in some instances, advantage may be obtained from the use of astringent lotions with counter-irritation over the mastoid process, or from the introduction of an artificial membrane, or, as suggested by McKeown, of Belfast, the application of collodion. In most cases, however, the treatment must be principally directed to the condition of the Eustachian tube and cavity of the tympanum—the former requiring dilatation by the use of the catheter, while the latter may require syringing, after previous incision of its membrane. *Ulceration* of the dermoid and fibrous laminæ of the membrana tympani may persist for many years, being accompanied with a muco-purulent discharge, and constituting one of the varieties of *Otorrhœa*. If the ulceration extend only to, but not through, the *mucous* lamina, the latter appears at the base of a depression corresponding to the ulcer, and protrudes when the tympanum is inflated. If the mucous lamina be also involved, perforation is apt to occur. The *treatment* consists in the application of a weak solution of nitrate of silver, with the administration of suitable constitutional remedies, and the adaptation of an artificial membrana tympani in case of perforation.

Calcareous Deposits in the fibrous laminæ of the membrana tympani may assume a concentric or a radiating arrangement, corresponding to the particular lamina involved. They consist chiefly of phosphate of lime, and do not appear to interfere particularly with the power of hearing, except when complicated with anchylosis of the stapes to the fenestra ovalis, or other deep-seated disease. No treatment is likely to prove of much service, but a trial may be given to the plan recommended by Toynbee, which consists in employing counter-irritation over the mastoid process, and in administering alteratives.

Incision of the Membrana Tympani, or even *Excision* of a portion of this structure, is occasionally of service in the management of the various affections which have been described. The chief objection to the treatment by *incision* is the temporary nature of the improvement, owing to the rapid healing of the wound; to obviate this, the surgeon may resort to the insertion into the cut, of a grooved vulcanite ring, provided with a silken thread to prevent its falling into the tympanum, as suggested by A. Politzer. *Excision* may be performed with an instrument specially devised for the purpose by Fabrizzi, or more conveniently with a simple double-edged knife and delicate forceps. In some cases, incision appears to act by diminishing intra-tympanic tension, as shown by the gaping of the wound; but in other instances no such effect is observed, though the resulting benefit may be equally great. Wreden, of St. Petersburg, recommends the *Excision of a Portion of the Malleus* with the adjacent membrane, and has devised an instrument by which the operation can be accomplished. Simrock, of New York, recommends, as preferable to *incision*, perforation of the membrana tympani by the application of *sulphuric acid*, while Bonnafont accomplishes the same purpose by using the *actual cautery*, employing for this object pencils made of charcoal and dragon's blood, and Purves employs the *galvanic cautery*.

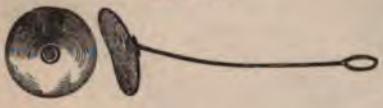
FIG. 376.



Politzer's method of inflating the tympanum.

Perforation of the Membrana Tympani may result from traumatic causes, from ulceration of this structure itself, or as a consequence of intra-tympanic inflammation — the mucus which accumulates within the cavity gradually making its way through the membrane, and being discharged externally. The perforation may be commonly seen by means of the speculum, and the patient can, if the Eustachian tube be pervious, blow air through the meatus by making a forcible expiration (or, as suggested by Dr. Schell, yawning) with the mouth and nostrils closed (Valsalva's experiment); or the surgeon may do the same by the use of the Eustachian catheter, or by Politzer's method, which consists in blowing air through the nostril into the pharynx while the patient swallows—the Eustachian tube opening during this act, and the air thus readily entering the tympanum. The surgeon may simply blow through a flexible tube; or, which is preferable, may use an India-rubber bag provided with a well-fitting nozzle (Fig. 376). In using Politzer's method, Hinton advises that the bag should be applied to the nostril of the opposite side to that of the ear which it is intended to inflate, and that the meatus of the sound ear should be firmly closed, so as to guard its membrana tympani from the effect of pressure. Gruber has modified Politzer's method by directing the patient, instead of swallowing, to pronounce the syllable "huck" or "heck." The *treatment* of perforation of the membrana tympani should be directed, in the first place, to an attempt to secure closure of the opening, which may sometimes be effected by the application of nitrate of silver or other astringent lotions, the insufflation of talc, etc. If, as often happens, the perforation is prevented from healing by the accumulation of inspissated mucus in the tympanum, the surgeon may resort to Hinton's plan of washing out this cavity, first with alkaline and afterwards with astringent solutions, injected by the syringe from the meatus through to the fauces. The nozzle of the instrument should be attached to a flexible tube which closely fits the meatus. By these means the parts may usually be restored to a healthy condition, when, even if the perforation persist, the hearing may be but little affected; if such is not the case, there is reason to suspect some loosening of the connections of the ossicula, and under such circumstances great benefit may be derived from the adaptation of an *artificial membrana tympani*, which may consist simply of a plug of cotton-wool dipped in glycerine (Yearsley), an India-rubber disk or globe, as recommended by Toynbee, a combination of both, as advised by Field, or a delicate metallic ring covered with gold-beater's skin, as suggested by Dr. B. Thompson, of New York. If one of the latter contrivances is used, a thread of delicate silver wire is attached, in order to facilitate removal.

FIG. 377.



Toynbee's artificial membrana tympani.

DISEASES OF THE EUSTACHIAN TUBE.

It has been shown by Toynbee and Jago, that the Eustachian tube is, contrary to what was formerly supposed, closed when in its ordinary condition,[1] and opened in the act of swallowing. In some cases, however, the Eustachian tube is more or less permanently open, giving rise to an abnormal sensibility to sounds originating in the patient's own throat, with a sense of discomfort in the fauces. This condition may arise in the course of catarrhal affections, and usually subsides spontaneously.

Obstruction of the Eustachian Tube may be due to a thickening of the mucous membrane of the fauces or tympanum, to a relaxed state of the fauces, to contraction of the bony walls of the tube itself, to the presence of inflammatory adhesions, to accumulations of mucus, etc. The *diagnosis* may be made by inspecting the membrana tympani through the speculum (the membrane, in cases of Eustachian obstruction, appearing concave, dull, and somewhat opaque), and by means of the *otoscope*, an instrument consisting of a flexible tube, one end of which is adapted to the patient's and the other to the surgeon's ear. If, when the otoscope is adjusted, the patient makes a forcible expiration (the mouth and nostrils being closed), the air, if the Eustachian tube be pervious, rushes into the tympanum, producing a sound which is distinctly audible to the surgeon. This sound, in a normal state, has been compared to that of a bullet striking a target at a great distance; it undergoes various modifications as the result of disease, being of a creaking or whistling character if the lining membrane of the tube be thickened, and gurgling if the tube or tympanum contain fluid. In cases of complete obstruction the sound is, of course, absent. The *rhinoscope* may be used to observe the condition of the orifice of the Eustachian tube.

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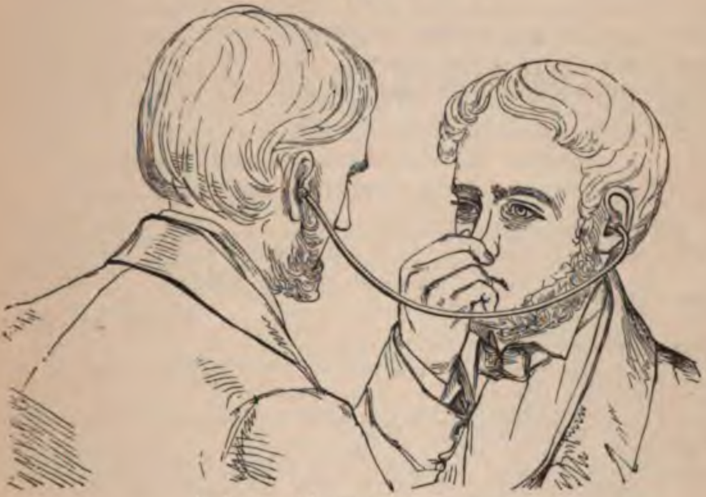
[1] This is still, however, denied by Rüdinger.

Obstruction from Thickening of the Mucous Membrane of the Fauces is a frequent cause of deafness in scrofulous children, and is often accompanied with enlargement of the tonsils. The *treatment* consists in restoring the throat to a healthy condition by suitable means, such as syringing solutions of carbonate of sodium or of common salt through the nostrils, applying nitrate of silver to the thickened membrane, or blowing powdered alum through a curved tube into the angle behind the tonsil, with the employment of counter-irritation around the throat, the use of tonics, etc. The cavity of the tympanum should be also inflated by Politzer's method (p. 713), this procedure being repeated as often as necessary, and, as advised by Hinton, the vapor of chloroform being substituted for air in cases of difficulty.

FIG. 378.



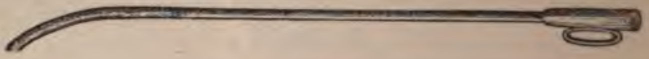
Application of the otoscope. (TOYNBEE.)

Obstruction from Relaxation of the Fauces occurs in adults, usually in those who are otherwise debilitated, and is said to be often due to excess in smoking. The *treatment* consists in the adoption of means to improve the general health, with the local use of stimulating and astringent applications.

Obstruction from Stricture of the Bony Walls of the Eustachian Tube, or from Inflammatory Adhesions, would require for recognition the introduction of an elastic sound as a means of exploration, but little or no benefit could be expected from treatment.

Eustachian Catheter.—In cases of obstinate Eustachian obstruction, the operation of *catheterization* is often required. This is effected simply by passing the catheter, its point being turned downwards, along the floor of the nostril, until the posterior pharyngeal wall is reached, and then drawing the instrument about half an inch forwards while its point is turned gently outwards and upwards, when it will usually readily enter the orifice of the Eustachian tube. Cutter, of Massachusetts, employs a catheter of his own devising, guiding its introduction, which is effected through the mouth, by the aid of rhinoscopy. The tympanum may now be inflated, when the surgeon can recognize the passage of the air by means of the otoscope, or, if inflation be impossible, dilatation of the tube may be attempted by means of bougies[1] of whalebone or laminaria digitata, introduced through the catheter, aided perhaps by the use of alkaline or astringent solutions injected through a small flexible tube. When inflation can at last be effected, a few drops of a weak solution of nitrate of silver may be syringed into the tympanum.

FIG. 379.



Catheter for the Eustachian tube.

DISEASES OF THE CAVITY OF THE TYMPANUM.

The diagnosis between deafness from tympanic lesions and nervous deafness may commonly be made by the use of the *tuning-fork*, the following rules for the employment of which are given by Hinton:—

1. In a normal state a tuning-fork is heard before the meatus after it has ceased to be heard on the vertex.
2. When placed on the vertex, it is heard more plainly when the external meatus is closed.
3. Consequently, when one meatus alone is closed, the tuning-fork is heard most plainly in the closed ear. Hence,
4. In cases of one-sided deafness, if the tuning-fork, when placed on the vertex, is heard most plainly in the deaf, or more deaf, ear, the cause is seated in the conducting apparatus; if it is heard loudest in the better ear, the cause is probably in some part of the nervous apparatus.
5. If, on closing the meatus, the tuning-fork is heard decidedly louder, there is no considerable impediment to the passage of sound through the tympanum.
6. If the tuning-fork is heard longer on the vertex than when placed close before the meatus, the cause of the deafness is in the conducting media.
7. However imperfectly the tuning-fork may be heard when placed on the vertex, it gives reason for suspecting only, and is not proof of, a nerve affection.

Lucae's "maximal phonometer" and "interference otoscope," and Politzer's "double otoscope," may serve as aids to diagnosis in certain cases.

Inflammation of the Mucous Membrane of the Tympanum is not unfrequently present, in its *milder* forms, in cases of common "cold" and sorethroat, giving rise to a deeply-seated pain in the ear, with buzzing noises, and slight impairment of hearing; inflation of the tympanum is painful, and an inspection with the speculum shows the membrana tympani to be more vascular than in the normal state. This affection, which constitutes the ordinary *ear-ache* of children, is very apt to recur at intervals, giving rise ultimately to a thickened and rigid condition of the mucous lining of the tympanum, and thus leading to permanent deafness. The

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[1] The dilatation of the Eustachian tube by the introduction of bougies is an operation which is by no means free from risk; it should therefore be looked upon as a last resort, and should be practised with great caution. *Medicated* bougies are employed by Buck, of New York.

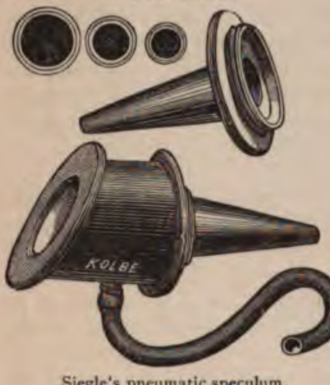
treatment consists in the use of soothing applications (such as warm glycerine and laudanum) to the meatus, with counter-irritation over the region of the mastoid process, during the attacks—followed by cold sponging, friction, and attention to the state of the throat during the intervals, so as to obviate recurrence. Sexton points out that, in some cases, disease of the middle ear is dependent upon affections of the teeth. Hinton recommends that the tympanum should be inflated with warm vapor every evening for a few days after each attack. The employment of *condensed* and of *rarefied air* in the external meatus is advised by Dr. Sexton, of New York.

In its *severer* forms, inflammation of the mucous lining of the tympanum is an extremely painful affection, attended with much constitutional disturbance, and sometimes with delirium. The symptoms of the milder form of the disease are all aggravated, and there is, besides, often great tenderness over the mastoid process, and in front of the ear. The affection may terminate in resolution, or in discharge through the Eustachian tube, or through the membrane of the tympanum; caries and consequent intra-cranial disease, and paralysis of the facial nerve, are occasionally met with as sequelæ of this affection. The *treatment* consists in the use of local depletion, with the application of hot anodyne poultices or fomentations, laxatives and diaphoretics being at the same time administered internally. Dr. A. N. Ellis suggests the instillation of atropia. Toynbee recommends gargling the throat with hot water, and the use of mercury with opium. Druitt advises an incision over the mastoid process, and the subsequent conversion of a part of the cut into an issue. If the case terminate in resolution, or in discharge through the Eustachian tube, the hearing will probably be gradually restored, and recovery may be promoted by the employment of counter-irritation, inflation of the tympanum with dilute vapor of iodine, etc., and syringing alkaline lotions through the nose. If the membrana tympani have given way, hearing may still be restored, and advantage may be derived in these cases from washing out the ear, by syringing alkaline and astringent lotions from the meatus through to the fauces, in the way already described (p. 714). The local application of alcohol is recommended in these cases by Cassels, of Glasgow, as is the insufflation of iodoform by Rankin, of New York; Howe employs a solution of permanganate of potassium (gr. ij–viij to f℥j). If the inflammation spread from the ear to the adjacent cranial bones, coma or death may follow.

Accumulation of Mucous or Serous Exudation within the Tympanum is, according to Hinton, a frequent cause of deafness, and when occurring in children, may give rise to convulsions, or, as in the otorrhœa of scarlet fever, etc., may even prove the immediate cause of death. The patient has very frequently the sensation of something being present in the ear and moving with the movements of the head; this feeling sometimes induces a habit of giving the head a peculiar shake, as if to shake the offending body out of the way; the hearing is often improved by holding the head down on the affected side. The membrane of the tympanum, as seen through the speculum, appears abnormally white, either generally or in parts. Percussion of the head is suggested by Hagen as a means of diagnosis of serous exudations, this producing a peculiar clinking or clattering sound in the affected ear. The *treatment* consists in incising the membrana tympani, usually at its upper and posterior part, thus converting the case into one of perforation of the membrane, and then daily washing out the cavity as directed in speaking of that affection (p. 714). The incision usually heals in four or five days, and the operation may be repeated, if necessary, in the course of a fortnight. As there is no doubt that convulsions in children are sometimes connected with, and probably dependent upon, the presence of mucus in the tympanum, Hinton judiciously advises that in cases of cerebral irritation in the young, the ears should be examined as regularly as the gums; a habit of rubbing the ears is almost as constant a symptom of this condition, as that of rubbing the gums is of the irritation of teething, and should receive at least as much attention. In these cases, beside incising the membrana tympani, counter-irritation by iodine may be properly applied around the ear, while the iodide of iron may be administered internally. The state of the throat should also be looked to. If the tympanic mucus be in a fluid condition, it may sometimes be evacuated through the Eustachian tube, either by the use of an elastic catheter as recommended by Purves, or by simply placing the patient in such a position that the fluid will escape by gravity, while the tympanic cavity is inflated by Politzer's method.

Membranous Bands are not unfrequently found in the tympanum, binding together the ossicula, or connecting them with the walls of the cavity itself. In many instances these bands consist merely of dried mucus, but in other cases they result from the organization of inflammatory lymph. They do not materially interfere with the function of the part unless so situated as to restrain the motions of the ossicula. The presence of these bands may be suspected if the membrana tympani appear irregularly concave, the Eustachian tube being pervious; but the most satisfactory means of diagnosis is the use of Siegle's *pneumatic speculum*, an instrument consisting of a box provided at one end with a magnifying lens, and at the other with an ear speculum which is made to fit the meatus closely by means of an India-rubber tube; another tube passes off from the box and is furnished with a mouthpiece, or, as suggested by Dr. Ely, of New York, a syringe, so that the surgeon can by suction make the membrana tympani move backwards and forwards, while at the same time he can, by looking through the lens, observe the effect produced. The *treatment* consists in inflating the tympanum, by which means the bands may sometimes be ruptured, in injecting solvent fluids, such as a solution of carbonate of sodium (gr. x–f℥j) through the Eustachian catheter, in the use of an ear-trumpet, etc.

FIG 380.



Siegle's pneumatic speculum.

Rigidity of the Mucous Lining of the Tympanum may result from the effect of chronic inflammation, or may be due to the gradual drying of accumulated mucus. The meatus in these cases usually contains little or no wax, and the membrane of the tympanum is normal, or slightly opaque, and is occasionally the seat of calcareous deposits. There is tinnitus, but no pain, and the air enters the Eustachian tube naturally, or with a flapping sound. There is not much absolute deafness, the patient hearing single sounds well enough, but failing to hear when a variety of sounds succeed each other in rapid succession—it being thus the *adapting power*, or, to borrow a word from ophthalmic surgery, the *accommodation*, of the ear which is chiefly interfered with. The patient may hear better when exposed to a noise, as the rattling of a railway train, than when in a still room.

The *treatment* recommended by Toynbee, consists in the application of a strong solution of nitrate of silver (ʒss–ʒj to f℥j) to the meatus, and of a weaker solution (gr. vj–f℥j) to the membrana tympani, with leeches below and counter-irritation behind the ear, and the internal exhibition of mercury. Hinton relies chiefly on the injection of medicated liquids into the tympanum, the substances which he prefers being carbonate of sodium (gr. x–xx to f℥j), muriate of ammonium (gr. x–fʒj) with ⅛ grain of corrosive sublimate, and sulphate of zinc (gr. ij–vj to f℥j). A few drops of the solution may be introduced by the Eustachian catheter, and blown into the tympanum by means of an elastic bag; or the patient may make the application himself by Gruber's plan, which consists in syringing about two fluidrachms of the solution through the nostril into the pharynx, and inclining the head to the affected side so as to bring the remedy into contact with the Eustachian orifice; by then inflating the tympanum without swallowing, a small quantity is forced into the cavity. Before resorting to either of these methods, the throat should be cleared of mucus by syringing an alkaline lotion through the nostrils. Applications may be made directly to the tympanum (as advised by Weber) by means of a flexible tube passed through the Eustachian catheter.

Anchylosis of the Stapes to the Fenestra Ovalis presents symptoms very analogous to those of the affection just described. The *treatment* usually recommended consists in the administration of alteratives, with the use of counter-irritation, but the results are not very satisfactory. *Exostoses* are sometimes developed on the *ossicula*, which may also be the seat of *fracture*, *dislocation*, *caries*, etc. The artificial membrana tympani is of use in some of these cases.

Periostitis of the Mastoid Process, or **Inflammation of the Mastoid Cells,** may accompany a similar condition of the *tympanum*, or may exist independently. If neglected, *caries* or *necrosis* may occur, followed, perhaps, by grave or even fatal cerebral complications. The most important point in the *treatment* is to make a free and early *incision* down to the bone in a longitudinal direction, half an inch behind the ear and extending the whole length of the mastoid process. If the symptoms persist, or, according to Dalby, if the bone be found healthy, the mastoid process itself should be *perforated* with a small trephine, or other suitable instrument, so as to lay open its cells and allow the free escape of matter. In order to avoid hemorrhage, Bagroff recommends that the opening should be made by the alternate use of the galvano-cautery and gouge. A *seton* to the nucha may also be of service in some cases.

Nervous Deafness.—The researches of modern aural surgeons have shown that most of the cases formerly classed under this head are really instances of some of the affections of the conducting media, which have already been described. Still, there are cases in which the auditory apparatus itself is at fault, and deafness may result from "concussion" or apoplexy of the auditory nerve, from fracture of or effusion of blood or lymph into the labyrinth (Ménière's disease), from cerebral affections, from syphilis, etc., while it may also occur as a reflex phenomenon, dependent on disease of the fifth nerve, or upon the irritation produced by intestinal parasites—or even as a "functional" affection, the result of anæmia and general nervous exhaustion. *Treatment* cannot be expected to accomplish much in cases of organic lesion of the brain or auditory nerve, but when the deafness is dependent on syphilis, or is a reflex or functional condition, the iodide of potassium, anthelmintics, or such other remedies should be given as may seem to be indicated by the particular circumstances of the case. Hypodermic injections of strychnia have been successfully employed by Hagen, of Leipsic, and, in cases of Ménière's disease, large doses of quinia have been advantageously resorted to by Charcot. *Ear-trumpets* will often prove of service.

Paralysis of the Tympanic Muscles is an annoying affection, interfering rather with the *accommodation* of the ear than with the absolute power of hearing. *Galvanism* might be properly tried in these cases.

Neuralgia of the ear is rare, except in caries or other disease of the teeth. The *treatment* presents no peculiar features.

Tinnitus Aurium sometimes exists as an isolated symptom,[1] and cannot be referred to any discoverable disease. In such cases, Hinton and Purves recommend muriate of ammonium, in 20-grain doses three times a day, with perhaps the injection of a few drops of a solution of atropia (gr. ⅛–f℥j) into the cavity of the tympanum. Kramer advises systematic dilatation of the Eustachian tube, and C. H. Burnett advises, in extreme cases, perforation of the membrana tympani, while Michael and S. M. Burnett recommend inhalations of nitrite of amyl, and Strawbridge the local use of ether by Politzer's method. Field speaks highly of the effects of faradization, and Woakes commends the internal use of hydrobromic acid. Reyburn has effected a cure by ligation of the occipital artery on the affected side.

Fatal Consequences of Inflammatory Affections of the Ear.—Inflammation attacking any of the deeper-seated structures of the ear, may occasionally lead to a fatal result by implication of the brain or lateral sinus—the immediate cause of death being, in the former case, meningitis or cerebral abscess, and, in the latter, thrombosis and inflammation of the lateral sinus, giving rise to secondary pneumonia or even sloughing of the lung. Nothing probably can be done to avert the fatal issue when these lesions are actually present, but much can be accomplished in the way of *preventive treatment* at the first onset of threatening symptoms. Rest in bed, local depletion followed by counter-irritation, the use of warm fomentations and syringing, with the internal administration of cathartics and the cautious employment of calomel and opium, may all be of service; but the most important point is to secure a free exit for discharge, by removing obstructions, incising the membrana tympani, trephining the mastoid cells, etc.

Medullary Cancer is occasionally observed in the ear (usually originating in the mucous membrane of the tympanum), and has been mistaken for polypus. Palliative treatment only is admissible in these cases, complete extirpation being out of the question, and a partial operation worse than useless.

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[1] In some cases, Hinton believes tinnitus to be caused by spasmodic contractions of the muscles of the ossicula. Chisolm has found it to be caused by twitching of the tensor tympani. According to Sexton, it may arise from friction of the ossicula upon each other, but more commonly originates in the blood circulation in the neighborhood of the ear, as pointed out by Theobald of Baltimore.

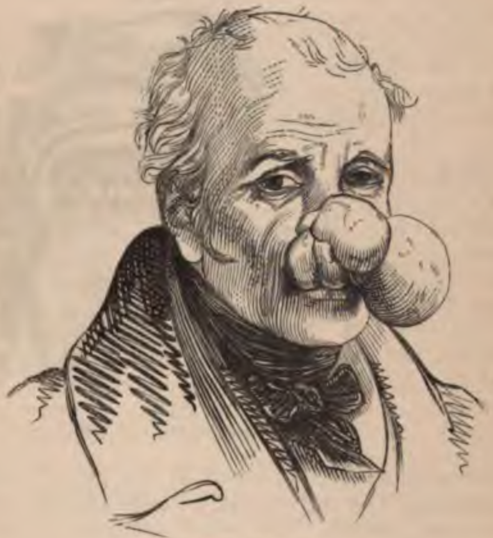
CHAPTER XXXVII.

DISEASES OF THE FACE AND NECK.

Diseases of the Nose.

Lipoma (*Acne Rosacea sive Hypertrophica*) is a hypertrophied condition of the cutaneous and subjacent cellular tissues of the nose, forming a red or purple, soft, lobulated mass, and causing great deformity. Anatomically, the disease should be classed as a fibro-cellular outgrowth. The sebaceous follicles of the nose often appear to be the parts principally involved. The *treatment* consists in excision, the only point in the operation requiring any particular attention being not to lay open the nostril; the occurrence of this accident may be avoided by causing an assistant to distend the part with a forefinger, that he may warn the surgeon if the knife penetrate too deeply. There is usually a good deal of hemorrhage, which may be checked by the application of cold. Healing takes place by granulation and cicatrization. To avoid bleeding, Ollier recommends the employment of the galvanic cautery.

Fig. 381.



Lipoma. (Liston.)

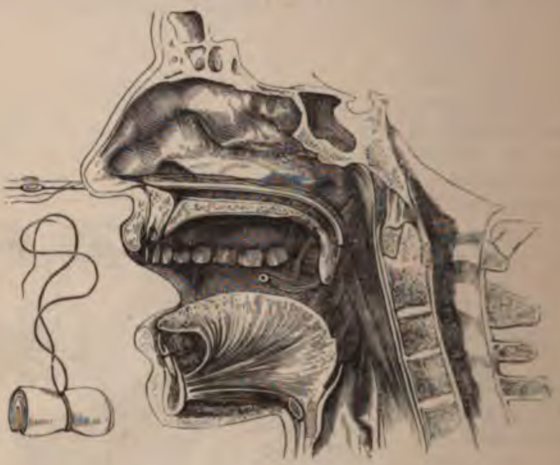
Imperforate Nostril.—This is occasionally, though rarely, met with as a congenital deformity; if the obstruction be not too deeply seated, it may be removed by incision and subsequent dilatation with bougies.

Epistaxis, or *Hemorrhage from the Nostrils,* is in many cases, particularly when occurring in young persons, an effort of nature to relieve internal congestion, and may be looked upon under such circumstances as rather salutary than otherwise. It is, however, even when not injurious, often annoying and inconvenient, and an attempt should therefore be made to prevent its occurrence, in persons liable to it, by administering laxatives to relieve visceral congestion, by attention to the menstrual function, etc. In most cases no further local treatment will be required than the application of cold to the nucha and forehead, or compression of the facial artery (as advised by Marin) over the superior maxillary bone, but in some instances, if the flow of blood be profuse and exhausting, more active measures must be adopted.

The patient should, under these circumstances, be kept quiet in bed, with the head and shoulders slightly elevated; the cold applications should be continued, and opium and gallic acid, ergot, or the acetate of lead, may be administered internally. An efficient local remedy is the muriated tincture of iron, which may be applied to the mucous surface of the nostril by means of a camel's-hair brush. An ingenious nostril-clamp has been devised by Dr. Caro, of New York, for treating hemorrhage from the anterior nares by compression.

As a last resort, it may be necessary to plug the nostrils; the *anterior nares* may be readily plugged with a piece of compressed sponge, or with a pledget of lint, introduced with slender forceps, and having a ligature attached to facilitate withdrawal; if the blood continues to flow backwards into the pharynx, the *posterior nares* must also be plugged—this being most conveniently accomplished by the use of Bellocq's sound, though, in the absence of this instrument, a double canula, or even a flexible catheter, may be used instead. The sound, previously armed with a strong ligature, is passed along the floor of the nostril till it reaches the pharynx, when, the spring being protruded, the ligature may easily be brought out of the mouth, and furnished with a plug of the required size. By withdrawing the instrument, the plug is now brought into position, the end of the ligature being allowed to hang out of the mouth to facilitate removal. Instead of merely plugging the posterior nares, it is often better to apply pressure to the whole floor of the nostril from behind forwards; this may readily be done by attaching to the ligature a series of moderate-sized plugs, which, as the instrument is withdrawn, are successively brought into position, or by using instruments[1] described by Küchenmeister and Closset under the name of *rhineurynters*, which consist of bags or sacs, to be inflated after introduction, like the colpeurynter of the accoucheur. The operation of plugging the posterior nares appears to be not entirely free from risk, Créquy and Gellé having recorded cases in which it was followed by suppuration of the middle

FIG. 382.



Plugging the nostrils with Bellocq's sound. (FERGUSSON.)

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[1] Similar contrivances have been suggested by Dr. Taaffe, Mr. Godrich, and Dr. Björnström, of Upsala.

ear. In a case of Verneuil's, in which epistaxis appeared to be due to cirrhosis of the liver, all other means failing, a cure was effected by the application of a blister to the hepatic region.

Chronic Inflammation with Thickening of the Schneiderian Membrane is not infrequent, especially among strumous children, though by no means confined to them. I have observed it in an adult, as the result of the mechanical congestion produced by constant vomiting during pregnancy. The portion of mucous membrane which lines the turbinated bones is that which is chiefly affected, appearing as a projecting ridge, or mass, of a red color and velvety appearance, sometimes covered with muco-purulent secretion. Respiration is obstructed, particularly in wet weather, the tone of the voice being altered, and a constant disposition to snuffling induced. The *treatment* consists in the application of astringents, frequent syringing with cold water, and (in a strumous patient) the administration of cod-liver oil, iodide of iron, etc. No operative treatment, except perhaps scarification, is admissible. Change of air is often beneficial.

Rhinorrhœa or Ozæna (the latter term referring to the fetid nature of the discharge) signifies a flow of muco-purulent matter from the nostrils, one or both of which may be affected. This condition is a symptom rather than a disease, and may be due to a simple catarrhal affection, to the presence of a foreign body, to scrofulous inflammation of the various nasal tissues, or to constitutional syphilis. In children it sometimes appears to be a reflex condition, dependent upon the irritation of teething. Scrofulous and syphilitic ozæna are often accompanied by ulceration, which may lead to caries or necrosis of the nasal bone, producing eventually great deformity.

In the *treatment* of ozæna, such constitutional means must be adopted as are indicated by the general condition of the patient; before resorting to local treatment, it may be necessary to explore the nasal cavity, the anterior portion of which may be readily inspected by means of a small bivalve speculum,[1] or the ingenious spring speculum devised by Wimmer, of Dresden, but the deeper portions of which can only be examined by the cautious introduction of a female catheter, Bellocq's sound, or Zaufal's speculum, or by a resort to *Rhinoscopy*. This mode of inspection requires the use of a small mirror which can be introduced into the pharynx, and of a reflector, if artificial light is to be employed. The ordinary mirror employed in laryngoscopy will commonly answer every purpose, or two mirrors, as advised by Voltolini, or the ingenious instrument devised by Dr. Simrock, of New York, may be used instead: this apparatus is provided with a movable spatula by which the soft palate may be raised, so as not to obstruct the surgeon's view. The most important point in the local treatment of ozæna is to secure cleanliness, by the use of a solution of the permanganate of potassium, or other disinfectant lotion, which may be applied with a large syringe, or by means of *Weber's* or *Thudichum's douche*. This consists of a reservoir containing the disinfectant, which is placed a little above the level of the patient's head, and is provided with a flexible tube which is introduced into the nostril. If the patient be now directed to breathe through the mouth, the soft palate closes the communication between the nose and pharynx, and a continuous stream is made to flow by atmospheric pressure into one nostril and out by the other. The force of the stream can be regulated by varying the elevation of the reservoir. If one nostril only be affected, the stream should pass from the healthy to the diseased side; while if both be affected, the direction of the stream may be alternated from one to the other. A *posterior nasal syringe* with long curved nozzle (Fig. 383), introduced by the mouth and made to inject fluids through the posterior nares, is preferred by many surgeons, and is probably a safer instrument, numerous cases having been reported by Roosa and others in which suppuration of the middle ear has followed the use of the ordinary douche, probably from entrance of the injected fluid through the Eustachian tube; a similar nozzle may be used with the ordinary douche, as recommended by Dr. George Thompson, of New York. Any *ulcers* that are detected should be touched with nitrate of silver, and, to prevent the formation of scabs, dilute citrine ointment may be applied at night by means of a camel's-hair brush. Letzel recommends the use of iodoform as a snuff, in the proportion of one part to five of powdered acacia, while H. Allen employs iodoform with carbolic and tannic acids, held in suspension in gelatine. The hypertrophied condition of the mucous membrane covering the turbinated bones may be treated by cauterization with nitrate of silver or chromic acid, as recommended by A. H. Smith, of New York, or, as preferred by Bosworth, with glacial acetic acid or the galvanic cautery. The same surgeon, with Dr. Jarvis and Dr. F. L. Knight, advises, in some cases, removal of the protruding part with a wire *écraseur*. Medicated *nasal bougies*, made with gelatine, have been recently employed in Germany. If *necrosis* occur, the sequestra should be removed as soon as they have become loose, access to the part being facilitated, if necessary, by Rouge's method of turning up the nose and lip by an incision through the mouth.

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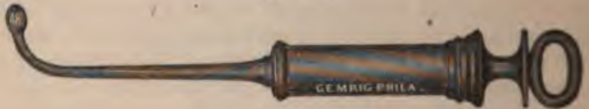
[1] Dr. H. Allen recommends a vulcanite speculum with an elliptical opening.

FIG. 383.



Posterior nasal syringe.

Adenoid Vegetations.—This name is given by Meyer, of Copenhagen, to certain growths met with in the naso-pharyngeal cavity, which appear to be identical in structure with the closed follicles of the mucous membrane from which they arise. The most prominent *symptom* is an interference with speech, the patient being unable to pronounce the nasal consonants *m* and *n*, and the voice being deficient in resonance; breathing through the nose is prevented, and the mouth is consequently kept open; there is, moreover, a feeling of obstruction at the back of the throat, with a copious flow of mucus, and sometimes slight hemorrhage; the patient frequently is deaf, and often suffers from otorrhœa or annoying tinnitus. The growths themselves have a velvety appearance, and a deep red or sometimes yellowish hue. The *diagnosis* may be made by the aid of rhinoscopy, or by digital examination. The *treatment* consists in *cauterization* with nitrate of silver, or, as preferred by Lincoln and Roe, with the galvanic cautery, or in *excision;* this may be done with a knife, composed of a ring-shaped blade with a slender shaft, with a sharp spoon, or, which Löwenberg prefers, with cutting forceps; and the operation should be followed by injections of saline or alkaline solutions.

Polypi.—The term *polypus* has been applied to a variety of nasal tumors, which have in common merely their locality and their pedunculated character.

1. The ordinary *Soft, Mucous,* or *Gelatinous Nasal Polypus* belongs to the

fibro-cellular variety of tumor (*myxoma*), and may spring from any part of the nasal cavity except the septum, though its more usual point of origin is one of the turbinated bones; occasionally polypi project into the nose from the frontal sinus or antrum. These growths are usually multiple, of a soft semi-gelatinous consistence, and of a grayish-yellow color while in the nasal cavity, becoming shrivelled and brown when they protrude externally. They produce a feeling of distension, and by obstructing the nostril impede respiration, alter the tone of the voice, and give rise to a disagreeable habit of snuffling; all the symptoms are aggravated in damp weather. As the polypi grow, they press upon and displace the neighboring bones, producing great deformity, obstructing the nasal duct and thus causing a stillicidium of tears, and eventually leading to caries of the turbinated bones. They sometimes protrude into the pharynx, where they may be seen, or at least felt by the finger introduced behind the soft palate.

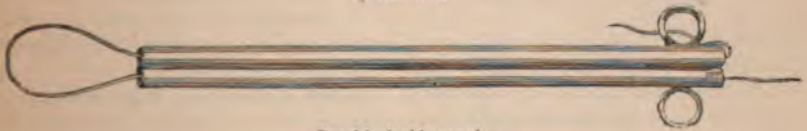
Treatment.—Nasal polypi have occasionally been successfully treated by the use of astringent injections,[1] but in the large majority of cases it is better to resort at once to an operation, which may consist in avulsion, in strangulation with the ligature, or in the use of the galvanic cautery; before attempting removal by any of these methods, the position of the pedicle of the tumor must be ascertained by exploration with a probe.

(1.) *Avulsion* is effected with delicate but strong forceps made for the purpose, with serrated blades and a longitudinal groove so as to afford a firm grasp. The patient being seated, with the head thrown backwards, one blade of the forceps is introduced on either side of the neck of the tumor, and the latter is then torn away by a combined process of twisting and pulling. The hemorrhage, though free, is seldom troublesome. Several polypi usually require removal, and the process has generally to be repeated at intervals. Insufflation of powdered alum has been recommended, with a view of preventing a recurrence of the disease.

When the posterior naris is the seat of the polypus, this may sometimes be conveniently removed by thrusting it backwards with one finger introduced into the nostril (the patient being etherized), and seizing it with a finger of the other hand introduced behind the soft palate.

(2.) *Ligation* is particularly adapted to large polypi with a broad base, or to such as project into the pharynx; the ligature, or, which Fergusson prefers, a loop of silver wire, is passed along the floor of the nostril by means of a double canula (Fig. 384), and slipped around the tumor by the aid of the finger introduced behind the soft palate. The loop being then tightened, the mass may be left to slough, or may be cut through, as by an *écraseur*. Sometimes the polypus may be thus withdrawn through the nostril, but it will commonly fall backwards into the throat—when it should

FIG. 384.



Gooch's double canula.

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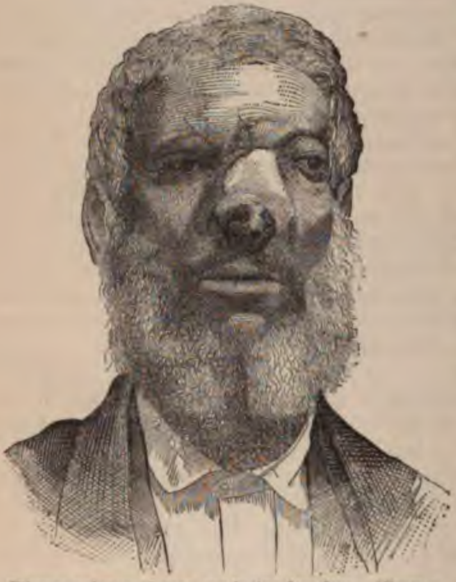
[1] Caro recommends interstitial injections of acetic acid, and Duplay and Barthélemy advise those of chloride of zinc, while Reginald Harrison practices puncture with a needle or fine trocar and canula, followed by the local use of carbolic acid and glycerine; B. W. Richardson employs the ethylate of sodium, applied on a pellet of cotton, and Miller, of Edinburgh, uses a spray of alcohol.

be instantly removed with forceps, lest by falling on the glottis it should cause suffocation.

(3.) Certainly the neatest, as well as the most expeditious, way of removing nasal polypi, however, is by means of the platinum wire loop *écraseur* and *galvanic cautery*. The loop being adjusted around the base of the growth, is heated by connecting the instrument with the poles of the battery, when the mass is severed with a slight hissing noise: the operation is both painless and bloodless. In some rare cases, in which the growth is very large, it is necessary, in order to expose the polypus sufficiently for the application of any means of removal, to lay open the cavity of the nose by an incision along the junction of the ala with the cheek.

2. *The Hard or Firm Polypi* of the nose belong to the class of *fibrous* tumors; they usually spring from the superior turbinated bone, or posterior part of the septum, project into the pharynx, and occasionally find their way into the antrum, through the pterygo-maxillary fissure, or even into the orbit. On the other hand, fibrous or fibro-nucleated tumors, originating in the antrum, or from the periosteum at the base of the skull (*Naso-pharyngeal Polypi*), may project into the nostril and be mistaken for intra-nasal tumors. Hence it may be, in some cases, an extremely difficult matter to decide, whether a particular growth should be called a tumor of the antrum, a nasal, or a naso-pharyngeal, polypus. The fibrous polypus is usually single, very vascular, and is apt by displacing the walls of the nose to produce the deformity known as frog-face. The symptoms are pretty much those of the soft polypus, but the fibrous growth may be distinguished by its consistence, by its color (a deep modena red), by its tendency to bleed, and by its not possessing hygrometric properties.

Fig. 385.



Fibrous polypus of nose, producing frog-face. (From a patient in the University Hospital.)

The *treatment* consists in *avulsion* or *ligation*, if the tumor be so small as to render these operations applicable, or in *excision*. In order to expose the growth sufficiently to render its complete removal possible, the surgeon may lay open the cavity of the nose, removing with cutting-pliers the nasal bone and the ascending process of the superior maxillary; may turn down the nose over the mouth by means of a ∩-shaped incision, as recommended by Ollier, the bridge of the nose being sawn through in the line of the external cut; may turn the nose to one side by cutting through its bony attachments with saw and chisel, as practised by Von Bruns and MacCormac, and by myself in the case from which Fig. 385 is taken; may cut through the hard and soft palate, as advised by Nélaton; or finally may resort to preliminary excision of the upper jaw. Either of the last-named operations may be employed in cases of true *naso-pharyngeal* polypus, the latter, which appears to have been first practised by Flaubert in 1840, being probably the best procedure. The operation is certainly justifiable, in view of the hopeless nature of the affection which it is designed to remedy (these cases, according to Nélaton, always proving fatal, either by hemorrhage, or by the obstruction to breathing and swallowing), but should not be too lightly undertaken, as it may prove immediately fatal by shock and profuse bleeding,[1] or may cause death at a later period by pyæmia or consecutive inflammation of the brain. It should be added that Gosselin advises delay and a resort to partial removal in cases of naso-pharyngeal polypus in young persons, believing that the disease manifests a tendency to self-limitation on the approach of adult life. The galvanic cautery has been successfully employed by Albertini. Duplay and Rochard advise injections of chloride of zinc, and Anger those of perchloride of iron; Verneuil divides the soft palate, removes the projecting part of the growth with the *écraseur*, and makes repeated applications of chromic acid to the remainder.

Osteo-plastic Resection of the Upper Jaw.—This is the name given to an operation which appears to have been suggested by Huguier in 1852 and 1854, but which was first practised by Langenbeck, and by which it is proposed to remove tumors lying behind the upper maxilla, without the extirpation of that bone. The necessary incisions being made, the saw is applied in such a way as to sever the connections of the jaw except at its nasal side, where it is left attached; it is then forcibly turned inwards, to be replaced after removal of the growth from behind it. Cheever, of Boston, has modified this operation by leaving the jaw attached by its palatal instead of its nasal connections, and has thus operated twice successfully on the same individual. In another case, the same surgeon displaced simultaneously *both* upper maxilllary bones downwards, to facilitate the removal of a naso-pharyngeal polypus occupying a median position, but the patient never fairly reacted from the operation, and died on the fifth day. A similar operation, in the hands of Tiffany, of Maryland, however, proved entirely successful. Cooper Forster has further modified Langenbeck's operation by displacing the jaw in an *outward* direction. Burow has successfully operated by Langenbeck's method, but, on the other hand, fatal cases have occurred in the hands of several surgeons, including Esmarch, Hill, and Verneuil.

Malignant Tumors of the nostrils usually belong to the *Encephaloid* or *Epitheliomatous* varieties. They may be recognized by their rapid growth; by their involving the neighboring bones, forming an elastic swelling; by their tendency to ulcerate and bleed; by the pain which attends their progress, and by the early implication of the neighboring lymphatic glands. In most cases, *palliative treatment* only is justifiable—complete extirpation being rarely practicable, while a partial removal could but aggravate the disease. If, however, the nature of the tumor be recognized at a very early period, and it appear that the growth actually originates in the nose, and does not (as sometimes happens) spring from the sphenoid or ethmoid cells, or even from within the skull, *excision* may perhaps be attempted by the following method. An incision carried from the inner angle of the eye downwards, alongside of the nose, lays open the nostril, while another incision across the cheek forms a flap which is to be dissected up. The superior maxilla is divided above its alveolar border, with saw and cutting pliers, a second section passing from the outer extremity of the first into the orbit; the nasal processs and nasal bone are then similarly severed, when a considerable part of the upper maxillary may be removed; the tumor is then to be extirpated, bleeding being checked by the use of the actual cautery, and by stuffing the cavity with lint soaked in Monsel's solution, or in the muriated tincture of iron.

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[1] Weir has recently recorded a case treated by Nélaton's method which proved fatal almost immediately after the operation.

In cases not admitting of any attempt at excision, *tracheotomy* may sometimes be required to avert death from suffocation.

Rhinolites, or *Nasal Calculi,* are sometimes met with in the cavity of the nostril, when they may be extracted with forceps, etc., as other foreign bodies; or they may be found beneath the mucous membrane, when they must be removed by careful dissection. They consist of phosphate and carbonate of lime, with magnesia and inspissated mucus, and are usually formed around a nucleus of some extraneous substance.

Diseases of the Septum.—The *septum nasi* may be the seat of hæmatoma or thrombus (the result of injury), of abscess, or of cystic or cartilaginous growths. The *treatment* of *thrombus* in this situation consists in the adoption of measures to promote absorption, while on the other hand, an early incision is indicated in case of *abscess.* Cystic tumors may be treated by cutting away a portion of the wall and applying nitrate of silver, while the cartilaginous growths require excision by the use of the knife and gouge. If perforation of the septum occur, in any of these affections, a plastic operation may be required to relieve the consequent deformity. Casabianca mentions two cases of chronic thickening of the nasal septum which had been mistaken for epithelioma. Schrœtter and Lefferts have observed cases of *double* septum occurring as a congenital deformity.

RHINOPLASTY.

The whole, or a portion merely, of the nose may be destroyed by injury, by ulceration with or without caries or necrosis, or by the ravages of lupus or of constitutional syphilis. Under these circumstances various *rhinoplastic* operations may be employed to relieve the deformity, it being, however, an invariable rule, that no operation is to be performed until the destructive process has been completely and permanently arrested.

Operation for Partial Restoration of Nose.—If the *columna* and part of the *septum* only be destroyed, a new columna should be fashioned from the upper lip, by making incisions on either side of the median line, so as to detach a strip of tissue about four lines wide and embracing the entire thickness of the lip; this strip, with its end suitably pared, is then turned upwards, and attached by means of the twisted suture to the lower surface of the nasal tip, which is previously freshened for the purpose. The wound of the lip is united with harelips pins, a few narrow strips of adhesive plaster serving to support the new columna in its place until firm union has occurred. The size of the newly formed nostrils must be maintained by the occasional introduction of gutta-percha or silver tubes.

If one *ala* of the nose only be deficient, the surgeon may, if the loss of tissue be but slight, take a flap from the upper part of the nose itself, and, freshening the edges of the border of the gap, attach the transplanted portion by a few points of suture. Under other circumstances the flap may be taken from the cheek (as I did successfully in the case of a woman whose husband, moved by jealousy, bit a piece from her nose), or, if the loss of substance be very considerable, from the forehead; in the latter case, the pedicle of the flap must be twisted upon itself, and, to prevent its sloughing, a groove may be cut for its reception on the dorsum of the nose. When union of the transplanted flap is complete, the pedicle may be raised and cut away, the groove being then closed with sutures.

A nose which is *too short* may be lengthened by Weir's method, which consists in cutting the organ across transversely, depressing the tip to the required extent, and filling up the gap with flaps taken from the cheeks.

Fistulous Openings through the nasal bones occasionally result from necrosis following scarlet fever, etc. Under such circumstances, a flap may be raised from the cheek or forehead, and attached by sutures to the freshened edges of the gap.

Operations for Restoration of the Entire Nose.—The whole nose may be restored by several methods, those best known being designated respectively as the *Taliacotian* and the *Indian* operation.

1. **The Taliacotian Operation** (so called from Taliacotius, a distinguished Italian surgeon of the sixteenth century), consists in fashioning a nose from the fleshy tissues of the arm.[1] A flap of sufficient size of skin and areolar tissue is first marked out, and partially detached, being left in this condition for a fortnight to become vascular and thickened by the process of granulation; the remains of the original nose are then pared, and the flap reduced to a proper shape and attached in its new position by numerous points of suture, the arm being approximated to the head, and fixed by a complicated system of bandages. After about ten days, when union may be supposed to be complete, the attachment of the flap to the arm is severed, and any trimming of the new organ which may be necessary effected. A columna is subsequently made from the upper lip. This process is so tedious and unsatisfactory, that it is seldom resorted to at the present day, though it has recently been successfully employed by MacCormac and Stokes. It has been modified by Warren and others, by taking the flap from the forearm, and by shortening the time during which the head and arm are fastened together. In order to supply a bony support for the new nose, Dr. Hardie, an English surgeon, transplanted the ungual phalanx of a *finger*, keeping his patient's arm fastened up to her face for *three months*.

2. **The Indian Method,** which was introduced into England by Carpue, in 1814, is that which is now generally preferred. In this procedure, a flap is taken from the forehead to form the greater part of the nose, the columna being subsequently made from the upper lip, though in some cases it is possible to derive the columna from the forehead also. The operation, as usually performed, may be divided into three stages.

(1.) The *first stage* consists in the formation and attachment of the *frontal flap*. A piece of thin gutta-percha should be first modelled to the size and shape of the organ which it is desired to reconstruct, and then should be flattened out and laid upon the forehead, so as to form a guide for the incisions, as shown in Fig. 386. As the flap—which may be taken from the middle or from either side of the forehead—is sure to shrink after its formation, a margin of a quarter of an inch should be allowed on all sides of the pattern, and it is convenient to mark out the lines in which it is designed to cut, with the tincture of iodine. If the patient have a very high forehead, the central portion of the flap may be prolonged, so as to form a columna, but, under ordinary circumstances, it is better to leave this part of the operation until a subsequent occasion. In raising the frontal flap, the surgeon should cut fairly down to the periosteum, beginning at the root, which should be made long, so that its circulation may not be interfered with when it is twisted. The flap should embrace all the soft tissues of the forehead down to the periosteum; and, indeed, it has been suggested that even this tissue should be included, in hope that osseous matter would be developed in the structure of the new nose. It does not appear, however, that such a result would be attended by any particular benefit, while the removal of the periosteum from the frontal bone exposes that part to the risk of necrosis. The flap, having been raised, is laid back upon a piece of wet lint, while the stump of the nose is pared and made ready for its reception. The integument should be dissected up in such a way as to form a groove for the reception of the frontal flap, the edges of which should themselves be shaved, so as to furnish two raw surfaces. All hemorrhage having been checked (if possible, without the use of ligature), the flap is to be twisted upon its root and adjusted, being held in place by means of the interrupted suture, or, which is better, the "tongue and groove suture" employed by Prof. J. Pancoast, of this city, the mechanism of which can be readily understood from the annexed diagram (Fig. 387). The flap should be supported by gently introducing beneath it a plug of oiled lint, or, if the columna have been made at the same time, two small plugs, one corresponding to each nostril. The extent of raw surface left upon the forehead may be diminished by the use of harelip pins. The patient is then put to bed in a warm room, with a fold of oiled lint over the part to preserve its temperature. The dressings should not be disturbed for several days, when it will usually be necessary to renew the plug, the sutures being allowed to remain until union has occurred.

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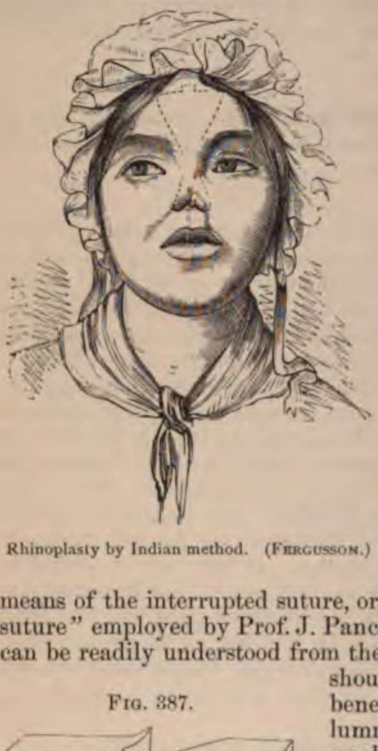
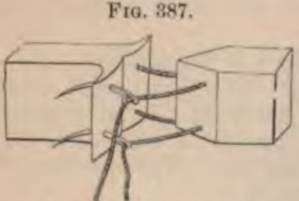
[1] It is scarcely necessary to say that the well-known Hudibrastic legend, which represents Taliacotius as making noses for his patients from the gluteal regions of other persons, is a *facetia* merely, without any foundation in fact.

Fig. 386.



Rhinoplasty by Indian method. (Fergusson.)

Fig. 387.



Tongue and groove suture.

(2.) The *second stage* of the operation consists in the formation of a columna, if this has not already been done in the previous part of the proceeding. The columna may be formed from the upper lip in the way directed at page 728.

(3.) The *third and last stage* consists in the separation of the root of the frontal flap, which may be done after an interval of about a month. A narrow bistoury being introduced beneath the twisted pedicle, is made to cut upwards, a wedge-shaped portion being removed, so as to make a smooth bridge to the nose; or, as recommended by Fergusson, the root of the newly-formed nose may itself be cut into a wedge and laid into an incision made for it in the forehead.

The size of the nostrils must be maintained by the patient's wearing, for some months after the operation, tubes of gutta-percha or silver. Rhinoplasty is usually a very successful procedure, though failure may ensue from sloughing of the flaps, or from a recurrence of the disease which caused the original deformity. Hemorrhage on the ninth day occurred in one of Liston's cases, and death even has followed the procedure, in the hands of so distinguished an operator as Dieffenbach.

3. **Syme's Method.**—The late Prof. Syme, of Edinburgh, devised an ingenious operation for the restoration of the nose, taking flaps of skin from the cheeks, as shown in the diagram, uniting them in the middle by sutures, and fixing their outer edges to raw surfaces previously prepared at a suitable distance from the nostrils. I have myself employed this method with a fairly satisfactory result.

4. **Wood's Method.** — Mr. John Wood has restored the nose by taking lateral flaps from the cheeks, and uniting them over an inverted flap, derived from the upper lip and elongated by splitting its mucous from its cutaneous surface, from the root of the flap to, but not through, its free border.

FIG. 388.

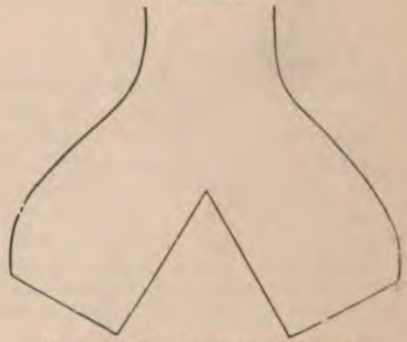


Diagram of Syme's rhinoplastic operation.

5. **Ollier's Method** consists in taking from the forehead a flap embracing the periosteum, and, having inverted this, covering it in with side flaps taken from the remnant of the nose.

Operation for Depressed Nose.—The nose may be flat and sunken from disease of its bones and cartilages, without external ulceration. Fergusson, modifying a proceeding of Dieffenbach's, remedied a deformity of this kind by separating the soft parts from the subjacent bones with a narrow knife, introduced within the nostril, and then bringing the whole organ forward by passing long steel-pointed silver needles across from cheek to cheek, and twisting them over a piece of perforated sole-leather. A columna was subsequently formed in the way already described.

DISEASES OF THE FRONTAL SINUSES.

Distension of the Frontal Sinuses from an accumulation of the natural secretion of the part has already been referred to (see p. 708). These cavities may also be the seat of *Abscess*, or may give origin to *Polypi*, which subsequently descend into the nostrils.[1] In either case the application of a trephine to the anterior wall of the sinus may be required.

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[1] Knapp has recorded a case of polypus of the frontal sinus in which there was no communication with the nostril, which remained unaffected.

DISEASES OF THE CHEEKS.

The cheeks may be the seat of *Encysted Tumors*, of *Epitheliomatous or Cancerous Growths*, of *Rodent Ulcer*, *Lupus*, *Warts*, *Moles*, etc. *Encysted tumors* may be removed by careful dissection, the operation being done from within the mouth if the cyst be nearer the mucous membrane than the skin. *Cancer* or *epithelioma*, occurring in this situation, if recognized at a very early period, might possibly admit of removal by excision; operative interference is, however, rarely justifiable in these cases, and would be positively contra-indicated by the existence of glandular implication. The treatment of *rodent ulcer* and *lupus* has already been considered (pp. 514, 515).

FIG. 389.

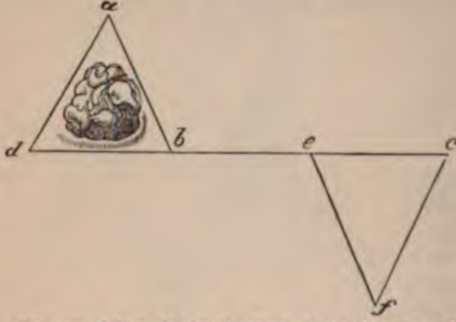


Diagram of Burow's plastic operation; the triangles *a d b* and *e f c* are dissected off, the flaps *a b c* and *d e f* loosened, and the lines *a d*—*a b* and *e f*—*c f* brought together.

If it be thought desirable to remove a *wart* or *mole* of doubtful nature from the face, this may be conveniently done by excision, the ensuing gap being closed, as advised by Stokes, of Dublin, by what is known as *Burow's operation*. A triangle of skin embracing the growth having been dissected off, the base of the triangle is extended to three times its length, and a similar triangle denuded in a reversed position, as shown in the diagram. Two flaps (*a b c* and *d e f*) are thus marked out, which are to be dissected up and slid in opposite directions, the edges of the wound coming readily together, and a linear cicatrix resulting.

Salivary Fistula usually results from accidental injury, but may occur as a consequence of operations on the cheeks, of the opening of abscesses, etc. For the treatment of this affection see page 348.

DISEASES OF THE LIPS.

Contraction, or even Closure, of the Buccal Orifice is occasionally met with as a congenital affection, or may result from the cicatrization of a burn, etc. The deformity may be remedied by a plastic operation, the details of such a procedure varying, of course, with each particular case. As a rule, the skin and mucous membrane should be separately divided, in the direction in which it is meant to enlarge the mouth, the cut surfaces being then pared and the mucous membrane everted, so as to form a new prolabium.

Hypertrophy of the Lips may depend upon the existence of the scrofulous diathesis, or may be caused by the irritation produced by fissures or ulcers, or, according to R. W. Taylor, by any affection such as asthma, or whooping cough, which induces violent and long-continued coughing, or violent efforts in respiration. In some rare cases, hypertrophy exists without any apparent cause, and under such circumstances the surgeon may be called upon to retrench the pouting lips, which, however charming in poetry, may, in real life, by the resulting deformity, occasion their owners no little annoyance. The operation consists in making two transverse incisions, so as to remove a sufficient slip from the thickness of the part, and then approximating the edges with delicate sutures. A similar operation may be employed to relieve the deformity known as *double lip*.

Tumors of the Lips.—*Cystic tumors* should be removed by careful dissection, mere excision of a part of the cyst wall not being sufficient in this locality.

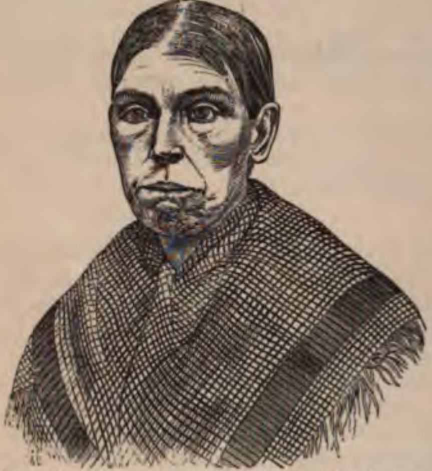
Erectile or vascular tumors of the lip may be treated by the application of caustic, by ligation, or by excision, according to the size of the growth and other circumstances of the case (see pages 538–542).

Epithelioma.—The *lower* lip is the favorite seat of epithelioma, though the disease occasionally attacks the upper lip. Epithelioma (which in this situation constitutes the affection commonly known as cancer of the lip) may begin either as a wart, or as an indurated fissure. It is much commoner in men than in women, rarely occurs before fifty years of age, and appears in many instances to be predisposed to by the use of a short pipe. This affection is to be *diagnosticated* from rodent ulcer, lupus, and labial chancre. *Rodent ulcer* is as rare in the lower as epithelioma is in the upper lip, while *chancre* may be distinguished by the *early* implication of the neighboring lymphatic glands, and by the effect of antisyphilitic treatment, which should always be tried in a doubtful case. The diagnosis of epithelioma from *lupus* may occasionally be very difficult, and indeed a lupous ulcer may sometimes become the seat of a true epitheliomatous formation. Lupus is, however, essentially a local disease, and does not involve the neighboring glands. The *prognosis* of epithelioma in this situation, if left to itself, is extremely unfavorable, death eventually ensuing from pain and exhaustion, or, if the disease extend to the neck, perhaps from hemorrhage. On the other hand, if submitted to early and thorough extirpation, the chances of permanent recovery are more favorable than in almost any other case of malignant disease.

The *treatment* consists in free excision with the knife, which is in almost all cases preferable to the application of caustics. As in some instances an ordinary ulcer may be so irritated by the presence of a broken tooth, or by the accumulation of tartar, as to assume an epitheliomatous appearance, any such sources of irritation should be first removed, when, if non-malignant, the ulcer will quickly heal under simple applications. Glandular implication does not necessarily forbid the excision of an epithelioma, provided that the affected glands are so situated as to render their own removal possible.

The *operation* must be modified according to the exigencies of each individual case: in most instances a simple V-shaped incision will be sufficient, an assistant compressing the lip and thus restraining the bleeding, while the surgeon transfixes the part from within, and cuts from below upwards, taking care to remove with the diseased part a wide margin of healthy tissue; the cut surfaces are then brought together with harelip pins, one of which serves to acupress the labial artery, while the accurate adjustment of the prolabium is secured by the introduction of a delicate silk suture. If a considerable extent of the margin of the lip be involved, it may be better simply to shave off the diseased portion, the mucous membrane being then brought forward, as advised by Serres, and stitched to the skin, so as to form a new prolabium. The result of such an operation is shown in the annexed wood-cut, from the photograph of a patient in the Episcopal Hospital. When a large portion of the lip has been removed, it may be necessary to close the gap by means of a *cheiloplastic* operation. In all cases, advantage may be obtained by freely dissecting the lip from its attachments to the jaw. Prof. Michel, of Charleston, has lately revived a suggestion of Richerand's, that the mucous lining of the lip (which is seldom involved) should be spared, the growth being carefully dissected away from it. The plan is ingenious, but I confess seems to me less safe than the ordinary method.

FIG. 390.



Formation of prolabium by Serres's method. (From a patient in the Episcopal Hospital.)

Cheiloplasty.—Various operations for restoration of the *lower lip* have been practised, the most generally applicable being, probably, those recommended by Zeis, Malgaigne, Serres, Mütter, Buchanan, and Syme. The operation practised by Chopart, consisted in the dissection of a quadrilateral flap from beneath the chin, as far as the position of the hyoid bone, this flap being then brought forward and attached in the normal position of the lip, while the head was flexed on the chest to prevent tension.

In Zeis's operation, which is a modification of Chopart's, the diseased structures are removed by means of a rectangular incision, and the tissues of the chin then included between oblique cuts, dissected up, and brought forward in the form of an inverted Λ to supply the gap.

FIG. 391.

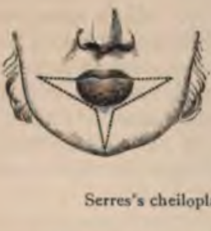
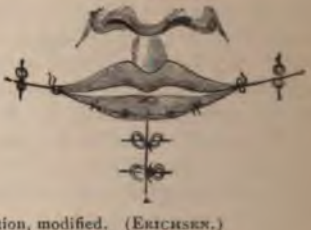


FIG. 392.



Serres's cheiloplastic operation, modified. (ERICHSEN.)

In Malgaigne's, and in Serres's operation (Figs. 391, 392), as in the old Celsian method, the tissues of the cheek are utilized in forming the new lip.

while in Mütter's and Buchanan's methods the flaps are derived from the chin. The diseased mass is first excised by an elliptical cut, from the centre of which[1] two incisions are carried downwards and outwards, the outline of the flaps being completed by two more incisions, parallel and corresponding to the branches of the first. These flaps are then raised and brought together in the median line by means of the twisted suture.

FIG. 393.

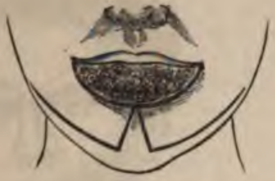
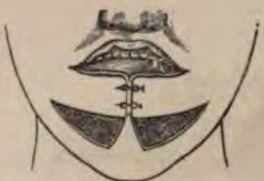


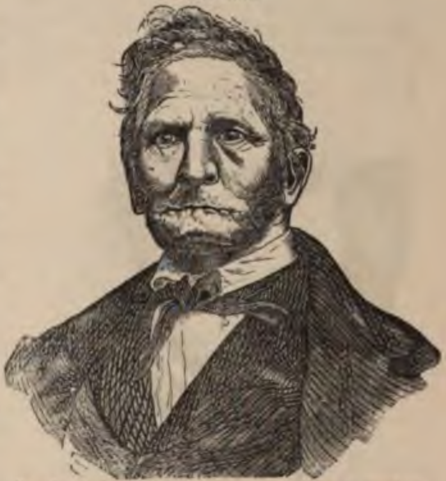
FIG. 394.



Cheiloplasty by Buchanan's method. (ERICHSEN.)

Syme's method differs from the above in that the diseased structure is removed by means of a **V**-shaped incision, passing from the angles of the mouth to the apex of the chin, the flaps to supply the gap being taken from below the ramus of the jaw and curved at their lower angle, so that by a little stretching the whole wound may be accurately closed with sutures, and union by adhesion thus obtained. In both methods, the new prolabium is formed by Serres's plan of uniting the mucous and cutaneous edges of the original wound of excision. The result of Syme's method is shown in the annexed illustration from a patient of mine in the Episcopal Hospital.

FIG. 395.



Result of cheiloplastic operation by Syme's method. (From a patient in the Episcopal Hospital.)

Restoration of a portion of the upper lip and of the angle of the mouth may be occasionally required to remedy the destructive effect of lupus. In a case of this kind at the Episcopal Hospital, I made a lozenge-shaped incision, as seen in Fig. 396, A B C D, when, by slitting the cheek transversely in the line B E, enough tissue was brought forward, as in Serres's operation, to close the gap in the lip, a new prolabium above and below being formed by stitching together the skin and mucous membrane. The result is shown in Fig. 397.

Ingenious operations for the restoration of large portions of the upper lip have been performed by Sédillot, Gurdon Buck, and other surgeons. The annexed cuts show the general plan and result of such an operation (Figs. 398, 399).

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[1] The late Mr. Collis, of Dublin, modified this procedure by leaving a space between the oblique incisions, as in Teale's operation (Fig. 161), having found that the central pillar, on which the new lip was elevated, gave better support if made square and not angular.

Fig. 396.

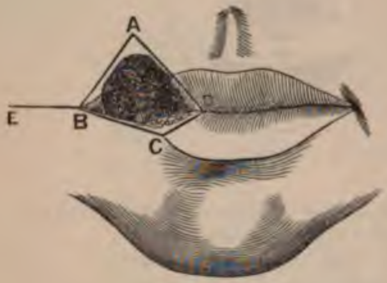
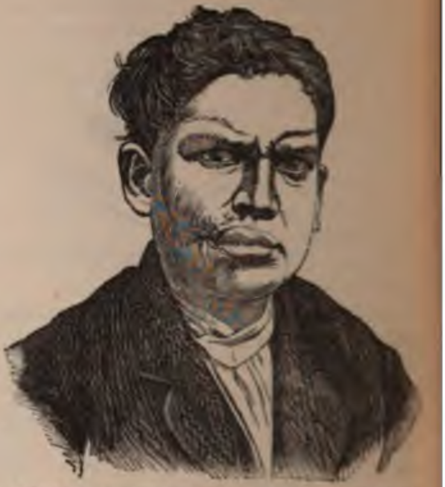


Diagram of operation for restoration of the upper lip and angle of the mouth.

Fig. 397.



Result of operation for restoration of the upper lip and angle of the mouth. (From a patient in the Episcopal Hospital.)

Fig. 398.

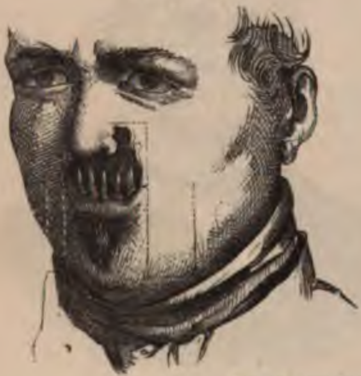
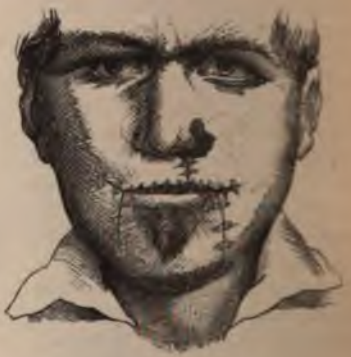


Fig. 399.



Restoration of upper lip. (Sédillot.)

Harelip.—This term is used to signify a congenital deformity, consisting of one or more fissures in the upper lip, resulting from an arrest of development. The fissure in harelip does not occupy the median line, as in the lip of the animal which has given the disease its name, but corresponds to the line of junction between the intermaxillary and superior maxillary bones, this line of junction being itself often deficient. When one side only is involved, the harelip is said to be *single;* in *double* harelip the intermaxillary portion is often displaced forwards, and may even be attached to the base of the nose, giving a peculiar snout-like appearance. In these cases one or both fissures may extend into the nostril, and the affection is not unfrequently uncomplicated with cleft palate.

Age for Operation.—As the deformity of harelip can only be remedied by operative interference,[1] the age at which this should be attempted becomes an important matter for consideration. Some surgeons have deprecated early operations, and have even advised that all treatment should be postponed until adult life; while others, going to the opposite extreme, have operated within a few hours of birth. Although it is impossible to give any positive rule upon this subject, it may be said, in general terms, that from six weeks to three months after birth is, in most instances, the period during which this operation should be by preference performed. If, however, the deformity interfere with the nutrition of the child, by preventing suckling, or by allowing regurgitation of food, the surgeon should not hesitate to operate at a much earlier period. The popular opinion that operations in infants are apt to be followed by *convulsions*, though sanctioned by the authority of Sir Astley Cooper, is, according to Butcher and Fergusson, incorrect; *shock* was, however, the cause of death in two cases of harelip operated on by the last-named surgeon.

Operation.—The operation for harelip consists essentially in paring the edges of the fissure, approximating the cut surfaces, and adopting means to prevent tension during the process of healing. Ether or chloroform may be properly used if the patient be beyond the period of early infancy, but in children less than three or four months old, it is, I think, better, on the whole, to dispense with any anæsthetic. The child should be firmly wrapped in a sheet and held by an assistant, the surgeon sitting behind the patient, and fixing its head between his knees. The lip should be first freely separated from the upper jaw by dividing the frænum and any membranous adhesions; an assistant then grasps the lip so as to control the labial artery, while the surgeon, seizing with toothed forceps the extremity of one side of the fissure, transfixes the part near the summit of the gap, with a small straight bistoury, and cuts downwards in a slightly curvilinear direction, concave inwards, so as to insure sufficient length to the cicatrix when the parts are brought together. The opposite side of the fissure is

FIG. 400.

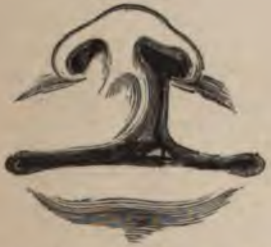
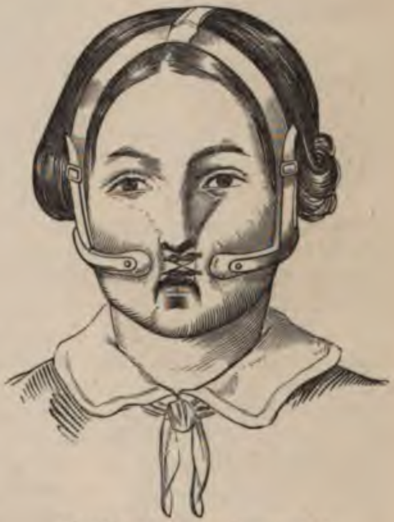


Diagram of common single harelip. (HOLMES.)

FIG. 401.



Cheek compressor. (FERGUSSON.)

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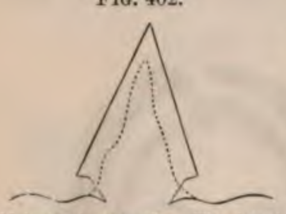
[1] Under the name of *preventive treatment* of harelip, Mr. Tuckey, an Irish surgeon, recommends the administration to the mother, during pregnancy, of a mixture of the phosphates of calcium and sodium, carbonate of calcium, bicarbonate of magnesium, chloride of sodium, gelatine, and gum, and reports several cases in support of his suggestion.

then pared in a similar manner, the incisions being evenly united above the summit of the gap, and extending far enough outwards to cut away the rounded edges of the prolabium at the base of the fissure. The cut surfaces are then accurately adjusted and held together with two or more harelip pins, the lowest of which is made to acupress the cut labial artery on either side. These pins should enter and leave the tissues at least a quarter of an inch from the lines of incision, and should embrace the whole thickness of the lip except its mucous lining. The more accurate adjustment of the prolabium may be effected by inserting a single interrupted suture through the mucous membrane, just behind the edge of the lip. In applying the twisted suture over the harelip pins, a separate thread or wire should be employed for each; the points of the pins being cut off, a strip of adhesive plaster is placed beneath them to protect the skin, and the dressing completed by supporting the tissues on either side by the use of gauze and collodion. Tension may be still further lessened by the use of Dewar's or Hainsby's cheek compressor (Fig. 401), or, in the absence of such an apparatus, by simply applying a long strip of adhesive plaster across the wound and around the head, as recommended by Coote. The pins and interrupted suture may commonly be removed on the third or fourth day, but the parts should be supported with adhesive plaster for at least a week or ten days longer.

FIG. 402.

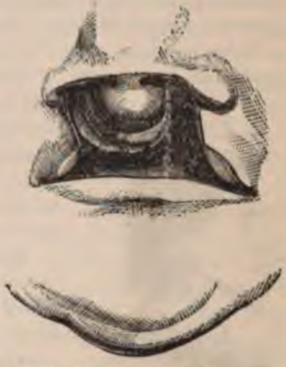


Malgaigne's operation. The dotted lines mark the fissure.

The above description will suffice for what may be considered the simplest form of operation in a typical case of single harelip. Various modifications are required under different circumstances; thus, if, as often happens, the sides of the fissure be of different lengths, the red edge pared from the shorter side may be left attached at its base to the lower border of the lip, and fastened to the previously sloped border on the other side, as advised by Langenbeck and Holmes; or a flap may be taken from the longer, and attached to the base of the shorter, side. To obviate the notch which is apt to be left at the lower border of the cicatrix, Clémot's and Malgaigne's plan may be followed, the incisions being made as shown in the annexed cut, or Nélaton's method may be adopted; this consists in surrounding the fissure with an inverted Λ-shaped cut, and bringing down the flap, which is left attached at both sides, so as to convert the wound into one of a diamond ◊ form. Many other very ingenious operations have been devised by Giraldès, Collis, Stokes, Wolff, and other surgeons, but, while more complicated than those in common use, have not, as far as I am aware, been proved to possess any practical superiority. Butcher and others operate with scissors instead of the knife, while the use of harelip pins has been abandoned by Mr. Erichsen in favor of the simple interrupted suture, as was likewise done by the late Mr. Collis; the latter surgeon used horsehair as a material for his sutures, while the former gives the preference to fine silver wire. Should the approximation of the cut surfaces be hindered by the projection of the intermaxillary bone, this may be cut away, as advised by Fergusson, with gouge or bone-forceps.

Double Harelip.—The treatment of double harelip is conducted on the same principles as that of the simpler form of the affection, both fissures being pared, and pins inserted so as to transfix the middle flap, and close both gaps at once; Coote, however, advises that the fissures should be operated upon on different occasions. In some instances, it is better to cut away the median portion, or to carry it upwards and backwards, so as to increase the length of the columna of the nose. The chief difficulty in cases of double harelip is in the management of the intermaxillary bone, if, as often happens, this interferes with the operation by its anterior projection. If it be small, the intermaxillary bone may be cut away (and indeed Fergusson recommends that this should always be done), but it is sometimes better to fracture its base, and bend it backwards into its proper position, with broad forceps covered with vulcanized India-rubber; this proceeding may be sometimes facilitated by dividing the attachment of the projecting bone to the septum with cutting forceps, as advised by Blandin and others, or by grooving its base with ingenious forceps devised for the purpose by Butcher, of Dublin; in case the intermaxillary portion should be found too large for the gap which it is meant to fill, its sides may be cut away with forceps, when the edges of the superior maxillary bones should be similarly freshened at the same time. In making these bone-sections, particularly in dividing the attachment of the projecting intermaxillary bone to the nasal septum, there is often free hemorrhage, which may require the use of the actual cautery; hence, in a case of this kind, chloroform should be used as an anæsthetic in preference to ether. Should it be thought necessary, the intermaxillary bone may be fastened by means of silver sutures to the adjoining maxillæ, as advised by Sims and Whitehead.

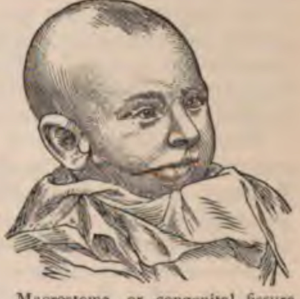
FIG. 403.



Double harelip: projecting intermaxillary portion. (HOLMES.)

Primary union is usually obtained without difficulty in cases of harelip operation, but if it should fail (which may happen from too early withdrawal of the pins, or from a depressed state of health in the patient), the surgeon should not despair, but should re-approximate the parts, in hope that union of the granulating surfaces will occur; in this way I have obtained a much more satisfactory result than might at first have been anticipated. If it be necessary to repeat the entire operation, an interval of at least a month should be allowed to elapse, in order that the parts may have time to return to a healthy condition.

FIG. 404.



Macrostoma, or congenital fissure at the angle of the mouth. (From a patient under Dr. Harlan's care, at the Children's Hospital.)

After the operation for harelip, the child, if an infant, may be allowed immediately to take the breast, the action of sucking tending rather to keep the parts together than to separate them; if already weaned, abundant nutriment in a fluid form should be supplied, and may be most conveniently administered with a spoon.

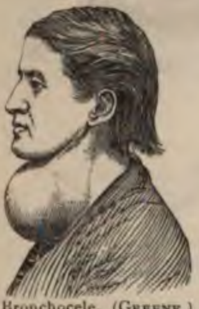
For further information with regard to the treatment of harelip, the reader is respectfully invited to refer to the chapter on this subject in Mr. Holmes's well-known work on the Surgical Treatment of Children's Diseases, where will be found an excellent account of the more complicated forms of the affection, and of the special operations required for each.

Congenital Fissure of the lower lip is occasionally met with, as is the same deformity at the *angle of the mouth*, where it constitutes the affection known as *Macrostoma*, of which I have seen one case under the care of Dr. Harlan, of this city; these rare conditions require to be treated on precisely the same principles as those which have been laid down for the management of ordinary harelip. Mr. J. H. Morgan and Mr. F. Mason have called attention to the coexistence of *macrostoma* and the deformity of the ear which is marked by the presence of the so-called *auricular appendages*. As may be seen from the annexed cut (Fig. 404), the same peculiarity was noticed in the case of Dr. Harlan's patient.

DISEASES OF THE NECK.

Bronchocele or Goitre is a hypertrophied state of the thyroid gland, and may exist in an independent condition, or in connection with anæmia and protrusion of the eyeballs, as in the affection known as *Graves's* or *Basedow's disease* (*Exophthalmic Goitre*). Other varieties are recognized by systematic writers, such as the *Fibrous Bronchocele*, the *Cystic Bronchocele*,[1] in which cysts are developed in the structure of the thyroid, with or without hypertrophy of the gland tissue itself, and the *Pulsating Bronchocele* (an affection which may be mistaken for carotid aneurism), in which the tumor has a distinct expanding pulsation, synchronous with the cardiac systole, and evidently depending upon the intrinsic vascularity of the growth itself.

FIG. 405.



Bronchocele. (GREENE.)

Bronchocele commonly appears as a soft, fluctuating, indolent tumor, occupying the situation of the thyroid gland, of which either lobe, or the isthmus, may be alone or chiefly involved, though in other cases the whole gland is equally implicated. The *causes* of bronchocele are somewhat obscure; it prevails in certain localities, as in the Tyrol and some parts of England, as an *endemic* affection, but is occasionally met with *sporadically* in all parts of the world, and as an *acute* affection has been observed as an *epidemic*. Goitre is much commoner in women than in men, and, according to A. Ollivier, is in many instances a result of pregnancy. In some cases, the prevalence of the disease appears to be traceable to the use of melted snow or of water impregnated with certain saline constituents, for drinking purposes; but in other cases no such cause can be assigned. The use of a tightly-fitting military stock, or other source of constriction about the neck, appears sometimes to have been an exciting cause of the affection.

When of moderate size, bronchocele gives rise to no particular inconvenience, except by the deformity produced, and by a certain amount of dyspnœa when stooping, with occasional pain in the head. In its more aggravated conditions, however, it may cause serious if not fatal interference with the functions of respiration and deglutition, cerebral congestion, organic disease of the air-passage, etc. When very large, as in a remarkable case under the care of Mr. Holmes, inflammation and suppuration of the mass may occur, and the patient may eventually sink under the drain thus occasioned.

Treatment.—The treatment of goitre is not very satisfactory; the remedy which has acquired most reputation in this affection is *iodine*, which may be given in the form of the Liq. iodin. compositus, of the U. S. Pharmacopœia, and should be continuously administered for a considerable time. Iodine may also be used externally, in the form of the Ung. plumbi iodid., or, the iodide of cadmium incorporated with simple cerate (℈j–℥j), or, which is particularly recommended by Mouat, the biniodide of mercury ointment (gr. xvj–℥j.) The internal administration of chloride of ammonium has been successfully resorted to by a Canadian surgeon, Dr. A. D. Stevens. *Pressure* sometimes forms a valuable adjunct to iodine inunction, but care must be taken not to irritate the skin, lest the disease should be thereby aggravated. *Change of residence* would naturally be recommended in any case in which the affection appeared to be due to climatic or other hygienic influences. Various *Operative Measures* have been employed in the treatment of bronchocele, each having been occasionally successful, but often resulting in failure, if not even more disastrously. The *injection of iodine, alcohol,* or *perchloride of iron*, the *formation of a seton*, and the application of *caustic*, are probably the safest of these measures. The *injection* treatment is said by Lubka and Mackenzie to be equally efficient in cases of the serous and in those of the hard or fibrous variety. Injection of *perchloride of iron* would be specially indicated if the growth were of the character described as pulsating bronchocele. The *seton* is particularly recommended by Lennox Browne, who has in several cases successfully employed it for fibrous goitre. Ollier dissects off the integument and applies a layer of Canquoin's paste to the tumor, allowing it to remain for four hours. Shrivelling gradually follows, and the cure is completed in three or four months. DaCosta and Coghill have derived advantage from the hypodermic use of *ergotine*. *Ligation of the thyroid arteries*, so as to cut off the vascular supply of the diseased gland, is a dangerous mode of treatment, and one which, on account of the freedom of the collateral circulation, is very apt to result in failure. *Division of the fascia* in the median line is recommended by Meade and Mackenzie as a means of relieving the pressure on the air passages, while, with the same object, Gibb advises that the thyroid isthmus itself should be divided or removed, hemorrhage being prevented by making the section between two ligatures. A similar operation was performed (unsuccessfully) by Prof. Hamilton, of New York, in 1849. *Extirpation of the gland* is an expedient fraught with considerable risk to life, and can only be justifiable in exceptional cases; when resorted to, care should be taken to plan the incisions so that the large vessels may, if possible, be encountered in an early stage of the proceeding, in order that, being secured once for all, the risk of subsequent bleeding may be less. Numerous successful operations upon this plan have been recently reported by Greene, Fenwick, Maury, Watson, Michel, Billroth, Kocher, Nelson, and other surgeons, Kocher's statistics giving 214 cases with 36 deaths, a mortality of less than 17 per cent.

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[1] Cohnheim has recorded a case in which cystic bronchocele was followed by metastatic deposits in the lungs and bones.

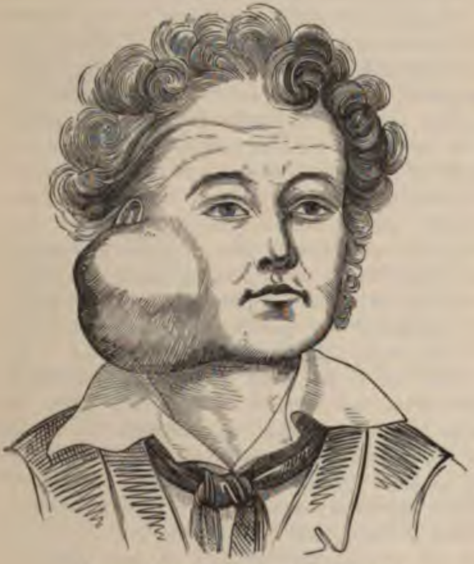
Exophthalmic Goitre (*Graves's or Basedow's disease*), supposed by Filehne to depend upon a lesion of the restiform bodies, comes more often under the care of the physician than of the surgeon; its treatment demands the adoption of means to improve the general health, rather than of measures specifically directed to the cure of the thyroid enlargement. Ancona, an Italian physician, reports a cure from galvanization of the sympathetic nerve in the neck. Digitalis and bromide of potassium have been successfully employed by Dr. Curtin, of this city.

Gangrene of the thyroid gland has been observed by Gascoyen and other surgeons.

Inflammation of the Parotid Gland may occur as an epidemic and probably contagious affection, when it constitutes the disease known as *Parotitis* or *Mumps;* or as the more serious condition denominated *Parotid Bubo,* which occurs in septic states of the system, or as a sequel of some of the exanthemata. The former affection very rarely, but the latter frequently, runs on to suppuration, demanding an early incision for the evacuation of matter, and the free administration of tonics and stimulants to support the strength of the patient. These cases are never unattended by danger, and in one case which I saw in consultation some years ago, death ensued from secondary hemorrhage into the cavity of the abscess.

Tumors of the Parotid.—Most of the tumors met with in the parotid region do not, probably, involve the gland, though they overlie and compress its structure; in some cases, however, the parotid itself is implicated in the morbid growth, which may be of a fibrous, cystic, fatty, cartilaginous, or cancerous nature. The only *treatment* applicable to these cases is extirpation of the growth, and, if the tumor be of a non-malignant character, such an operation may be commonly undertaken with the probability of a favorable result. If, however, the growth be cancerous, its attachments will probably be so deep as to forbid any hope of successful operative interference. The *mobility* of such growths is, according to Fergusson, the best criterion by which to decide whether or not to operate; and in any case in which it can be determined that the tumor, though perhaps bound down by superincumbent tissues, is not firmly fixed to the parts beneath, the inference is reasonable that an operation may be attempted with hope of benefit. Another point of importance is the rate of increase of the tumor, one of a non-malignant being of much slower growth than one of a malignant character.

FIG. 406.



Tumor of parotid region. (FERGUSSON.)

In attempting the removal of tumors from the parotid region, the external incisions should be free, and may be made in any direction that may be indicated by the shape of the growth; after dividing the superincumbent tissues, and thus loosening the tumor, the surgeon should accomplish the rest of the operation as far as possible by pulling and tearing with his fingers, aided with the handle of the knife, being chary of employing the cutting edge in the deeper portions of the wound. The accidents to be particularly guarded against are wounds of the temporo-maxillary artery and facial nerve, division of the latter of which would of course entail paralysis of the corresponding side of the face.

Excision of the Parotid Gland itself is probably less often done than is supposed; yet so many cases of this operation have been recorded by perfectly competent and trustworthy observers, that it is impossible to deny the practicability of the procedure. In this operation, which is one of the gravest in the whole range of surgery, the external carotid artery and portio dura nerve are necessarily cut across, and in some instances it is said that the internal jugular vein, and even the spinal accessory and pneumogastric nerves have been likewise divided. Extirpation of the parotid, which is said to have been performed by Heister, is chiefly known in this country through the operations of the late Dr. George McClellan, of this city, who reported eleven cases with only one death.[1]

Tumors of the Submaxillary Gland.—*Cysts* of the submaxillary gland are occasionally met with, and may be treated by *incision*, the cavity of the cyst being stuffed with lint, so as to promote healing by granulation, or by *excision*, which operation may also be required in cases of *cartilaginous*, *adenoid*, or *cancerous*, growths. The gland should, as far as possible, be enucleated with the fingers and handle of the knife; the only large vessel necessarily severed is the facial artery, which will be found at the upper and posterior part of the wound, and may usually be secured before it is divided.

Tumors of the Neck.—Various morbid growths are met with in the side of the neck, where they may occupy the submaxillary space, or one of the triangles of this region. The most common varieties of cervical tumor are the cystic, fatty, fibrous, and glandular, though cancerous and epitheliomatous growths are also met with in this part. The remarks which were made with regard to the excision of parotid tumors are equally applicable here; if the tumor be movable and of slow growth, its extirpation may, if the other circumstances of the case are favorable, be properly undertaken. If, however, the deep attachments of the mass are firm, and if its rate of increase has been such as to render its malignancy probable, the surgeon will, as a rule, do wisely to avoid operative interference.

Hydrocele of the Neck is a name applied by Maunoir, Phillips, Syme, and other surgeons, to a cystic tumor, usually met with in the posterior inferior cervical triangle, and containing a fluid which may be of a limpid yellow color, or of a deep, grumous, chocolate hue. The *treatment* consists in the evacuation of the contents of the cyst, with a trocar and canula, followed by the subsequent injection of iodine, the establishment of a seton, or the conversion of the cyst into an abscess, by cutting away a portion of its anterior wall. A similar course may be adopted in the treatment of *Cysts of the Parotid Region* (unconnected with the gland itself), of *Hygromata of the Hyoid Bursa*, and of similar enlargements of the subcutaneous bursa sometimes found in front of the larynx, which constitutes the "*Superlaryngeal Encysted Tumors*" of Prof. Hamilton.

Enlargement of the Cervical Lymphatic Glands is often observed as a manifestation of scrofula. Its treatment has been already described in the chapter on that subject (see page 428).

Congenital Tumor or Induration of the Sterno-mastoid Muscle is an obscure affection, which has been described by several surgeons, particularly Bryant, Holmes, T. Smith, H. Arnott, and Planteau. In some cases the affection appears to originate from injury received in birth, but in other instances is a simple inflammatory or hypertrophic condition, with no apparent cause. It is probably sometimes a syphilitic lesion. No *treatment* is required, as the induration subsides spontaneously in the course of a few weeks or months.

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[1] The operation is said to have been performed for the first time in this country by Dr. Richard Banks, of Georgia, in 1832.

CHAPTER XXXVIII.

DISEASES OF THE MOUTH, JAWS, AND THROAT.

DISEASES OF THE TONGUE.

Glossitis, or *Acute Inflammation of the Tongue*, may occur from traumatic causes, from the abuse of mercury, or as an idiopathic affection. The tongue rapidly swells, becomes œdematous, and protrudes from the mouth, preventing the patient from speaking or swallowing, and perhaps threatening actual suffocation. There is profuse salivation, and the teeth often become covered with sordes. The *treatment* consists in the local use of ice, with detergent and astringent gargles, the administration of tonics (if the patient can swallow), and, if necessary, the use of nutritive enemata. *Free incisions* on the dorsum of the tongue may be required if the symptoms are urgent, and commonly afford great relief, by allowing the escape of the blood and serum by which the organ is distended. *Tracheotomy* may possibly be required to avert suffocation.

Chronic Superficial Glossitis is the name given by Copland and Fairlie Clarke to an affection of the lingual mucous membrane characterized by the formation of smooth, elevated patches, and believed by Clarke to be often of syphilitic origin; according to Butlin, it is closely allied to *psoriasis* and *ichthyosis linguæ;* it is sometimes followed by epithelioma. Clarke recommends the local use of nitrate of silver (gr. v. to f℥j) and glycerite of tannin, with the internal administration of iodide of potassium and arsenic.

Sub-Glossitis.—Under this name, C. Holthouse has described a case in which inflammatory swelling, occurring without obvious cause, was limited to the sublingual and submental regions; the tongue was retracted instead of being protruded, and there was no dyspnœa, though speech and deglutition were both rendered difficult; there was profuse salivation. Incisions on the dorsum of the tongue were productive of no benefit, but rapid recovery followed the use of borax gargles, with cataplasms externally, and the administration of quinia. Similar cases are described by Dolbeau under the name of *acute ranula.*

Hemi-Glossitis, an inflammatory swelling, limited almost invariably to *left* side of the tongue, has been observed by Langelot, De la Malle, Graves, and recently by Guéneau de Mussy. Dr. Parella and Dr. Cleborne report cases in which the *right* side of the tongue was affected.

Abscess of the tongue is occasionally met with, and requires a free incision for the evacuation of pus. An abscess beneath the tongue may, by pressing on the glottis, threaten suffocation, in which case the incision must be made below the chin, through the mylo-hyoid muscle.

Hypertrophy or Prolapsus of the Tongue may be met with either as a congenital or as an acquired affection. The protruded organ is very much swollen, with enlarged papillæ, of a purple or brownish hue, and dry from exposure to the air. The saliva constantly dribbles from the mouth, and, in chronic cases, the alveolus and teeth of the lower jaw are displaced forwards by the pressure of the hypertrophied mass, which, according to Wegner and other modern pathologists, consists of a true lymphangeioma. The *treatment* consists in the use of astringents, with the application of compression by means of a pad and bandage, supplemented, if necessary, by excision of a V-shaped piece from the tip of the organ, with the knife, galvanic cautery, or *écraseur*. Ligation is objectionable on account of the proximity of the organ of smelling to the point at which the slough would be produced, and the risk of septic poisoning which would be necessarily entailed. The statistics of these various modes of treatment have been investigated by Fairlie Clarke, who finds that 20 cases in which cutting instruments were employed gave 19 recoveries and 1 death; 10 cases in which compression alone was employed gave 9 recoveries and no deaths (one patient having been much benefited, though not entirely cured); 4 cases in which either the galvanic cautery or the *écraseur* was used gave 3 recoveries and 1 death; while 9 cases in which the ligature was used gave 7 recoveries and 2 deaths. Dr. Gurdon Buck, of New York, suggested that, as the thickness of the protruding portion is commonly more obnoxious than its breadth, the flaps for excision should be made antero-posteriorly rather than from the sides of the organ.

Atrophy, affecting only one side of the tongue, has been noticed by several observers, including Dupuytren, Holthouse, Hughlings Jackson, Budd, Habershon, Jaccoud, Fagge, Weisser, Fairlie Clarke, and Paget. In the case recorded by the last-named surgeon, the disease was connected with necrosis of the occipital bone, and yielded upon the extraction of sequestra from that part.

Ulceration of the Tongue may be due to the irritation caused by broken or carious teeth, to disorders of the digestive system, to the existence of various diseases of the skin (such as psoriasis), to syphilis, to the presence of a malignant growth, to a deposit of tubercle, etc. The differential diagnosis between these various forms of ulceration is highly important in a therapeutic point of view, as the treatment required varies widely, according to the cause of the ulceration in each case. In most instances the diagnosis can be readily made by careful observation of concomitant symptoms; the most difficult cases being, perhaps, those in which a chancre or tertiary syphilitic deposit is to be distinguished from an epithelioma (see pages 459, 465), or the latter from an ulcerated mass of tubercle.

The *Tuberculous Ulcer* has been particularly studied by Trélat,[1] who remarks that any chronic, intractable, superficial ulcer, with red, irregular borders, which occurs, without appreciable cause, and without enlargement of the neighboring lymphatic glands, on the tongue or in the mouth, is probably a tuberculous ulcer; and that the probability is increased if the patient be phthisical or tuberculous, or even predisposed to tuberculosis. The diagnosis, he adds, may be considered certain, if the surgeon can detect the presence of peculiar spots or patches, which are very slightly elevated, round, from half a line to two lines wide, of a yellowish, pus-like color, at first covered with epithelium, and exhibiting one or more follicular orifices—the epithelium disappearing in the course of a few days, and leaving an ulcerated surface. The only topical remedy which proved of benefit in M. Trélat's case was the application of the actual cautery, but Verneuil has successfully employed chromic acid, which, according to Hybord, is a preferable remedy.

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[1] Archives Gén. de Médecine, Janv. 1870.

Ichthyosis of the Tongue is the name given by Hulke to a chronic condition of this organ (characterized by the appearance of white or silvery patches), which may persist without change for years, but which ultimately leads to the development of epithelioma in the parts affected. According to Dr. R. W. Taylor, however, there are two varieties of ichthyosis; one in which the papillæ are primarily involved, giving the tongue a warty appearance, and the other beginning in the rete Malpighii. The first variety alone is, in Dr. Taylor's opinion, liable to malignant change. The *treatment* of this disease, of which examples have been reported by H. Morris, Fairlie Clarke, Goodhart, Weir, of New York, and others, consists in excision, or, if this be not practicable, in removing sources of irritation, with attention to the digestive functions and, as suggested by Fayrer, the administration of arsenic.

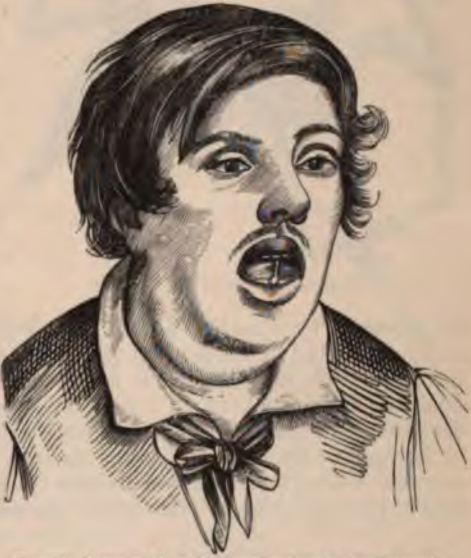
Tongue-tie consists in a congenital shortening of the *frænum linguæ*, which prevents the tongue from being protruded beyond the line of the teeth. If present in an aggravated degree, this deformity may interfere with suckling, and, under any circumstances, the operation for its relief is so trifling that it may properly be done, if, as usually happens, the parents desire its performance. The operation consists simply in dividing the frænum for about an eighth of an inch with blunt-pointed scissors, the cut being made towards the floor of the mouth, so as to avoid the ranine vessels, and then separating the parts with the forefinger. There is a popular notion that tongue-tie may cause dumbness, and myotomy of the lingual muscles, through an incision beneath the chin, has even been performed, with a view of restoring the power of speech—a totally useless operation, since, as justly remarked by Holmes, the whole tongue itself may be extirpated, and yet the power of speech remain.

Tumors of the Tongue.—*Cystic Tumors* may occur in various parts of the tongue, but are most common beneath this organ, or in the floor of the mouth below the buccal mucous membrane, constituting in these situations the affection known as *Ranula*. The common form of ranula has thin walls, and contains a fluid somewhat resembling saliva, whence it was formerly supposed to be a dilatation of the duct of the submaxillary gland. Such is, indeed, probably the case in some instances, as when occlusion of the duct is caused by the presence of a foreign body or a salivary calculus; but the majority of ranulæ appear to be distinct cystic formations, analogous to those which are met with in other organs. Masses of *adipocere* were found in a ranula in a case recorded by Warren Tay, and numerous *rice-like* bodies in one described by J. G. Richardson, of this city. True *hydatids* have been noticed in the tongue by Laugier, Mollière, and other surgeons. The common form of ranula may be treated by the formation of a seton, or by excision of a portion of its anterior wall, the cavity being subsequently allowed to heal by granulation. Panas advises the injection of chloride of zinc. That variety of the disease which is met with between the floor of the mouth and the mylo-hyoid muscles often forms a more decided prominence in the neck than in the buccal cavity, and hence would appear to be most accessible through an external incision. The risk of hemorrhage, however, in any attempt at complete extirpation is so great that it is, as a rule, better to lay open the tumor from within, and turn out its contents, thus converting the cyst into an abscess, the healing of which may be promoted by stuffing the cavity with lint.

Acute ranula, in which the tumor forms in the course of a few hours, is believed by Tillaux to consist in an accumulation of saliva (from obstruction and rupture of Wharton's duct) in a serous sac known as Fleischmann's bursa; the existence of this bursa is, however, denied by Sappey, Lefort, and others, and Duplay considers the acute ranula to consist in a dilatation of the duct itself. Dolbeau includes under the head of acute ranula, cases which are analogous to those already referred to under the name of *subglossitis*.

Erectile, Vascular, and Papillary Tumors are occasionally seen in the tongue, and may be treated by the ligature, by excision, or by strangulation with the *écraseur*, according to the size and situation of the growth. Dr. Busey, of Washington, D. C., reports a case of papilloma of the tongue successfully treated by the injection of acetic acid.

Fig. 407.

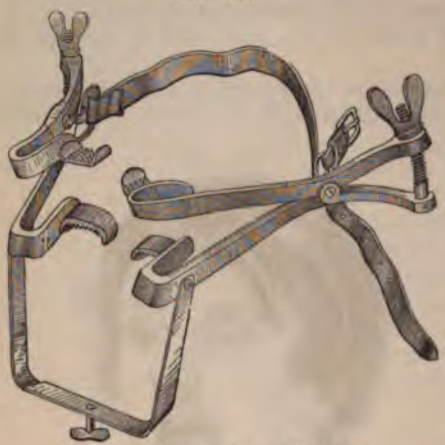


Ranula, between floor of mouth and mylo-hyoid muscles. (Fergusson.)

Fatty, Glandular, and Fibrous Tumors of the tongue may be treated by excision, the organ being drawn well forwards with a tenaculum or cord passed through its tip. Hemorrhage in these cases is sometimes rather troublesome, but may usually be arrested by passing a metallic suture deeply around and across the bleeding point, by means of an ordinary nævus needle or one with a spiral extremity. Excision would appear to be a safer operation than ligation, in cases of tumor involving the root of the tongue. Apart from the risk of inflammatory swelling and œdema of the glottis, which attends the use of the ligature in this situation, severe or even fatal cerebral complications may be developed as reflex phenomena (as in a case recorded by Hunt), from injury to fibres of the glosso-pharyngeal nerve. If the tumor were situated very far back, and were pedunculated, the *écraseur* might be properly employed, as has been successfully done by Bigelow and Pooley.

Malignant Tumors of the Tongue are almost invariably of an *epitheliomatous* character, though true lingual *cancers*, both of the scirrhous and encephaloid kinds, are described by systematic writers. The only treatment which offers any prospect of benefit, consists in removing the diseased mass, which, when a portion only of the organ is affected, may be accomplished by the galvanic cautery, or by the application of the *écraseur*, or of ligatures as in cases of nævus, or by excision, which is the preferable operation when the tip only is involved. H. Lee employs, in addition to the ordinary ligature, one which is elastic, so as to prevent any risk of imperfect strangulation and consequent absorption of septic material. The elastic ligature has also been employed by Desprès, Delens, and other French surgeons. The tongue may usually be sufficiently exposed in these cases by drawing it well forwards, the jaws being held apart and the cheeks retracted, by such an instrument as is shown in Fig. 408. If, however, a large portion of the organ is to be removed, the *écraseur*, galvanic cautery wire, or ligatures, may be introduced through an incision in the cheek as advised by F. Jordan and Coppinger, or between the genio-hyoid muscles, as practised by Cloquet, Arnott, and Whitehead, of Manchester; or Regnoli's plan may be adopted, in which the buccal cavity is opened from below (Fig. 409), and the tongue drawn out between the lower jaw and hyoid bone; or Kocher's plan, in which the opening is made below the angle of the jaw. Southam has devised forceps to grasp and draw forwards the base of the tongue, so as to allow the *écraseur* to be used without making an external wound. Clamps to prevent bleeding during operations upon the tongue have also been devised by H. Lee and by J. W. Howe, of New York.

Fig. 408.

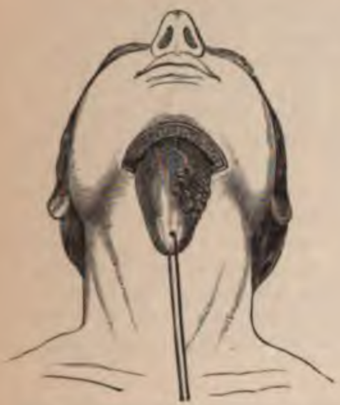


Wood's gag for operations on the tongue.

Tumors of the Epiglottis are occasionally observed, and Dr. W. Porter has recorded a case in which he successfully excised half of the epiglottis on account of a cartilaginous growth developed in its substance. Tumors of the epiglottis have also been removed by MacKenzie, Prat, and Wagner, the latter surgeon having excised the whole epiglottis, after exposing the part by a sub-hyoidean pharyngotomy.

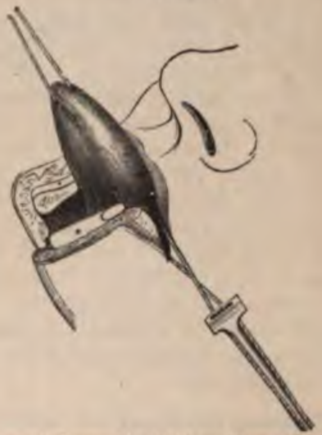
Complete Extirpation of the Tongue was first performed by Syme, of Edinburgh, and has since been repeated by Fiddes, Nunneley, Heath, Annandale, Langenbeck, Buchanan, Barwell, and many other surgeons, some operators having employed the knife, and others the *écraseur;* Whitehead removes the whole tongue with scissors. Whichever instrument be chosen, access to the organ may be facilitated by Syme's plan of dividing the lower lip and the symphysis of the jaw, the parts being wired together again after the completion of the operation, or, which will usually be sufficient, by simply laying open the cheek by an incision from the angle of the mouth backwards. Annandale advises that the tongue should be split longitudinally, and each half removed separately with the *écraseur*. Nunneley's experience in extirpation of the tongue appears to have been unusually large; he has, he declares, done the operation 19 times "without any untoward symptoms following in a single instance." Langenbeck prefers to Syme's median operation, an incision from the angle of the mouth to the thyroid cartilage, the jaw being then sawn through between the first and second molar teeth, and the shorter portion turned outwards and upwards. Barwell makes a small median incision, just in front of the hyoid bone, and by means of an armed needle carries the wire of an *écraseur* around the base of the tongue, puncturing the mouth on either side near the last molar tooth; the tongue having been cut through, the operation is completed by dividing its attachments to the floor of the mouth with a second *écraseur*. The external wound being oblique and valvular, there is no danger of a fistula resulting.

FIG. 409.



Tongue exposed by Regnoli's method. (ERICHSEN.)

FIG. 410.



Removal of tongue by division of lower jaw and écraseur. (ERICHSEN.)

These operations are all dangerous in themselves,[1] and are seldom productive of more than temporary benefit; they are, of course, only applicable to cases in which the disease is limited to the tongue itself, extensive implication of the floor of the mouth or of the neighboring lymphatic glands being a positive contra-indication. Hilton and Moore have recommended as a palliative measure, in cases not admitting of excision, the *division of the gustatory nerve*—an operation which may also be resorted to as a preliminary to the application of ligatures. The nerve may be reached just behind the last molar tooth, by an incision crossing its course, made from within the mouth, and carried freely down to the bone. *Ligation of the lingual artery* has been also practised as a means of arresting the progress of malignant disease of the tongue, and, according to Coote, Demarquay, and Haward, with encouraging results. The same operation is recommended by Weichselbaum, Hirschfeld, and Shrady, as a preliminary measure to extirpation of the tongue; the risk of hemorrhage is thus reduced to a minimum, and the operation can be safely completed with the knife. Shrady urges that the vessel should be secured near its origin, before the giving off of the dorsalis linguæ. *Tracheotomy*, as a preliminary measure, is recommended by Barker.

Contrary to what might perhaps be expected, the power of swallowing is not affected by extirpation of the tongue, while speech, though at first rendered imperfect by the operation, is eventually completely restored.

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[1] According to Barker, 34 cases operated on at University College Hospital, from 1871 to 1879, gave 11 deaths as the immediate result of the operation.

DISEASES OF THE JAWS.

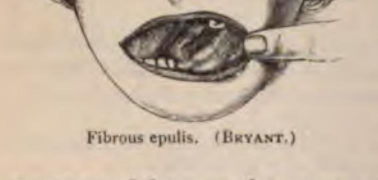
Abscess of the Gum (*Gum-boil, Alveolar Abscess*) is a common affection, resulting from the irritation of necrosed or carious teeth. The abscess forms in the socket of the tooth, and may extend inwards—bursting through the gum—or may spread outwards through the cheek. In the early stage of a gum-boil, the application of a few leeches to the inflamed gum will often afford great relief from pain, and may even prevent the occurrence of suppuration; if, however, pus have actually formed, it should be evacuated by an early and free incision, made from within the mouth as soon as fluctuation can be detected in that position. As it is very desirable to avoid the deformity caused by an external opening, an effort should be made to obtain resolution on the side of the cheek, pointing being at the same time encouraged within the mouth. For this purpose it will usually be advisable to avoid the use of poultices, substituting an embrocation of the extract of belladonna, diluted with glycerine. The patient may be at the same time directed to wash out the mouth frequently with warm water, or the domestic remedy of a hot fig may be applied to the inner side of the inflamed gum. As soon as the acute symptoms have subsided, whether by the occurrence of resolution or of suppuration, the services of a dentist should be invoked to remedy the diseased state of the offending tooth, and thus avert a recurrence of the affection.

Lancing the Gums is a little operation often required in cases of difficult dentition. It is most conveniently performed with the instrument known as the "gum lancet," though, in an emergency, the small blade of an ordinary penknife will serve the purpose perfectly well. The child's hands should be restrained by the mother or nurse, while the surgeon, separating the jaws with the left forefinger, introduces the blade of the lancet guarded with the right forefinger; this serves to guide to the point at which the incision is to be made, and at the same time keeps the child's tongue out of the way of injury from the knife.

Ulceration of the Gums may depend upon the presence of a scorbutic or syphilitic taint, or may result simply from a disordered state of the digestive system, the accumulation of tartar around the teeth, etc. The *treatment* consists in the adoption of means to improve the patient's general condition, with the enforcement of cleanliness of the part, and the local use of astringent and detergent washes.

Epulis.—This is a general term signifying an outgrowth of the gum, the growth in these cases being rather of the nature of a continuous hypertrophy than of a distinct tumor. The ordinary epulis is of a fibrous structure, but myeloid, cancerous, and epitheliomatous growths are also met with in this locality. The disease chiefly affects the lower, but is also met with in the upper, jaw, rarely occurs before adult life, and is equally common in either sex. It is usually traceable to the irritation produced by a decayed tooth. The *Fibrous Epulis* appears as a red, smooth, lobulated mass, covered by the natural structures of the gum, the mucous glands of which are sometimes abnormally developed. The growth is at first firm and resisting, but may become soft-

FIG. 411.



Fibrous epulis. (BRYANT.)

ened by central disintegration, or may ulcerate superficially. The *Malignant Epulis,* as it is commonly, though improperly, called, is usually of a myeloid character; in some instances, however, as already observed, these growths are really malignant, being of an epitheliomatous or cancerous nature. The malignant differs in appearance from the simple or fibrous epulis, in being softer, of a darker color, more vascular, and of more rapid growth, and in its tendency to recur after removal.

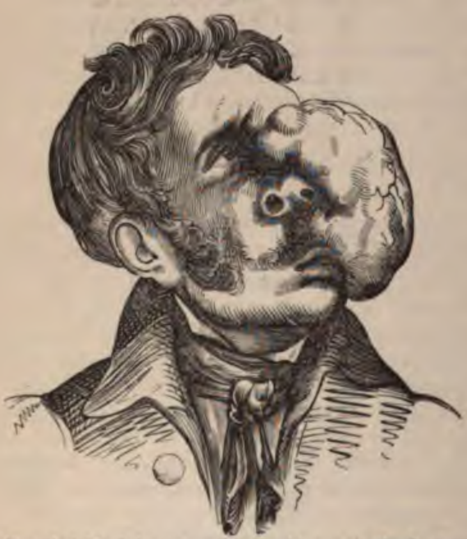
The most available mode of *treatment,* in any case of epulis, is excision, and as the growth commonly involves the periosteum, this, with a thin layer of the subjacent bone, should be removed with the gouge-forceps, so as to prevent a recurrence of the disease. In ordinary cases, the whole operation may be done from within the mouth, but if the tumor be large, and particularly if of a myeloid character, it may be necessary to make an incision through the median line of the lip, and then dissect off the cheek so as to freely expose the whole growth. A tooth should be extracted on either side of the diseased mass, and the alveolus divided with a strong but small saw as far as the base of the tumor. Cutting pliers, with the blades at a right angle to the handles, are then to be applied, one blade on either side of the jaw, when the whole growth, with the bone from which it springs, can be readily cut away. The *base of the lower jaw* should always be allowed to remain, in order to preserve the symmetry of the part; the removal of the whole thickness of the bone appears to be quite unnecessary, epulis, according to Heath, never involving the lower border of the jaw. If the bone be very thick, it may be desirable, before applying the cutting forceps, to make a horizontal groove with a Hey's saw; but in most instances this will probably be found unnecessary. Hemorrhage is to be checked by compression, or, if this fail, by the use of the actual cautery or Monsel's solution of iron, the external wound, if one have been made, being then accurately adjusted with harelip pins and the twisted suture. The bleeding is often profuse in operations for the removal of malignant epulis, requiring the free use of the hot iron; in these cases, also, it may be necessary to remove the entire thickness of the bone, by means of an external incision beneath the horizontal ramus of the jaw. Mr. Nunn has reported several cases of epulis successfully treated by electrolysis.

Necrosis of the Jaws may result from traumatic causes, from syphilis, from the abuse of mercury, or from the contact of the fumes of phosphorus (as in the makers of lucifer matches); it is, moreover, sometimes met with as a sequel of the eruptive fevers, and may even occur without being traceable to any definite cause. In the upper jaw, the disease is almost invariably limited to the alveolar border, but in the lower jaw, may involve the whole thickness of the bone. The *treatment* consists in the administration of nutritious food and tonics, with the use of detergent lotions, and an *early removal of sequestra;* as long as a portion of dead bone remains in the mouth, the patient is constantly exposed to the risks of septic poisoning. Removal should, if possible, be effected without resorting to external incisions; in the upper jaw this can be readily accomplished, but if the whole thickness of the lower jaw be involved, an incision below the ramus may be absolutely necessary; Perry and Boker have, however, each succeeded in removing the whole lower jaw, in a state of necrosis, through the mouth, and Hutchison, of Brooklyn, has in a similar manner removed the whole upper jaw and the malar bone. Linhart, of Berlin, has removed the greater portion of both upper jaws, while preserving the muco-periosteal covering of the hard palate and the incisor teeth.

Abscess of the Antrum.—Suppuration may occur in the antrum as the result of traumatic causes, or of the irritation produced by a diseased tooth or by a sequestrum resulting from syphilitic or other disease of the jaw. The symptoms are those of deep-seated suppuration in general, with enlargement of the part, causing swelling of the cheek, protrusion of the eyeball, occlusion of the lachrymal duct and nostril, and bulging of the hard palate. If the accumulation of purulent matter be very great, the walls of the antrum may become so attenuated as to crackle under pressure. Pointing may take place on the cheek, or within the mouth, or the abscess may possibly discharge itself through the nostril. The *treatment* consists in making a free opening into the antrum, and, subsequently, in daily washing out the cavity by syringing with warm water. If one of the molar teeth be carious, this may be extracted, and an opening made by thrusting a trocar, small perforator, or, which Fergusson recommends, an ordinary gimlet, through the socket, but, under other circumstances, it is better to make the opening through the front wall of the antrum beneath the cheek; the bone is here thin, and can be readily perforated with a strong knife or scissors. External pressure may be afterwards employed to restore the part to its original shape.

Cysts of the Antrum (*Dropsy of the Antrum*).—The antrum is not unfrequently the seat of a collection of thin glairy mucus, or of a brownish serous fluid containing crystals of cholestearine. The older surgeons looked upon these cases as the result of an obstruction of the orifice of the antrum, causing accumulation of the natural secretion of the part, and hence applied to them the term *hydrops antri*, or *dropsy of the antrum*. Modern pathologists, however, believe that, at least in the large majority of instances, these are (as first pointed out by Giraldès) examples of true cystic disease, analogous to those which are met with in other parts. The *symptoms* of a cyst of the antrum are very much the same as those which characterize abscess of that cavity, except that no evidence of an inflammatory condition is present. The *diagnosis* is important, as these cases are curable by a very slight operation, whereas solid tumors of the antrum demand a much graver procedure for their removal; hence, in any case of doubt, the surgeon should make an exploratory puncture before resorting to more serious measures. The *treatment* of cystic disease of the antrum consists in perforating the anterior wall of the cavity from within the mouth, the cheek being previously dissected up if necessary. A small portion of the anterior wall may be excised, so as to allow thorough exploration of the part, and prevent reaccumulation. If, as sometimes happens, a

FIG. 412.

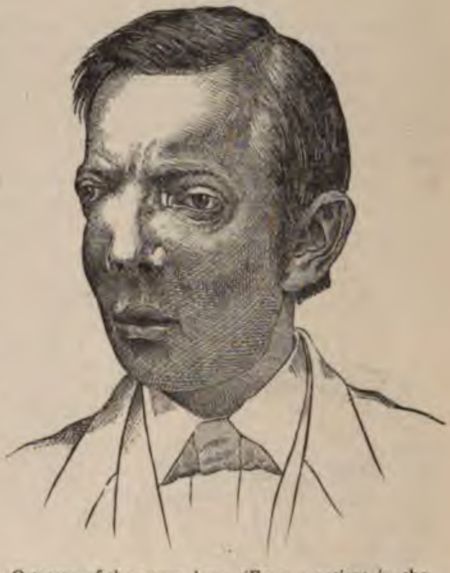


Encephaloid of the antrum, encroaching upon the face. (LISTON.)

tooth be discovered within the antrum (in which case the cyst is said to be *dentigerous*),[1] the tooth should be removed with suitable instruments, introduced through the opening already made.

Solid Tumors of the Upper Jaw.—These are of various kinds. Apart from those which have already been described under the name of *epulis*, there may be exostoses springing from the surface of the jaw, and projecting in different directions, requiring removal with gouge, saw, or cutting pliers. Tumors, again, may originate from either wall of the antrum, from the malar bone, from the pterygo-maxillary fossa, or from behind the jaw; fibrous, myeloid, and encephaloid growths are probably those most frequently met with in these situations, though fatty, cartilaginous, bony, and epitheliomatous tumors have also been observed in the same localities. These various growths, as they increase in size, produce swelling of the cheek; encroach upon the orbit, causing protrusion or compression of the eye, and sometimes interfering with vision; occlude the nostril, simulating nasal polypus; project into the pharynx, causing dyspnœa or dysphagia; and depress the alveolus and hard palate, causing bulging of the roof of the mouth. Beside the deformity produced, they eventually endanger life, by interfering with respiration and deglutition, by giving rise to profuse and repeated hemorrhages, or by involving the base of the skull, and inducing cerebral complications.

FIG. 413.



Osteoma of the upper jaw. (From a patient in the University Hospital.)

Diagnosis.—Solid tumors, involving the antrum, may be distinguished from *cysts or abscesses* of the same part, by noting the history of the case, by observing the uniform, elastic, and semi-fluctuating character of the enlargement, in the case of a fluid collection, and, finally, by means of an exploratory puncture. It may, however, happen, as in a patient under my care at the Episcopal Hospital, that the entrance to the antrum is blocked by a solid growth, the natural secretion of the part accumulating as a consequence, and constituting a true dropsy of the cavity. Under such circumstances the diagnosis would necessarily be obscure, until the gradual increase of the solid tumor should render its nature apparent.

It is sometimes a matter of great difficulty to determine the *point of origin* of a tumor involving the upper jaw; those growths which spring from the *malar bone*, dip downwards between the gum and cheek, causing the latter to project at an early period, and only secondarily involve the antrum; tumors, again, which originate *in the antrum*, distend its walls in various directions, and render the line of the teeth irregular; while, finally, growths which originate *behind the jaw* (as naso-pharyngeal polypi), thrust the latter downwards and forwards as a whole without altering the line of the teeth, or changing the relative position of the several parts of the bone. These distinctive points are, however, in practice, often obscured by the fact that a tumor arising in one position may send prolongations in several different directions, so that, in any particular case, it may be almost impossible to decide from what part the growth originally sprang.

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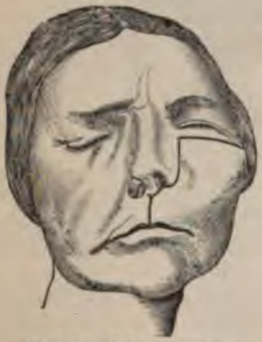
[1] According to Magitot, maxillary cysts of spontaneous origin are invariably connected with some portion of the dental system.

The diagnosis between *malignant and non-malignant* tumors of the antrum is often extremely difficult, as long as the morbid growth is confined within the walls of that cavity. A malignant affection may, however, be suspected, if the increase of the tumor be rapid, if the patient be past the period of middle age, and particularly if the submaxillary glands be enlarged and indurated. When the growth has spread beyond the cavity of the antrum, the diagnosis is comparatively easy, the ordinary characters of a malignant tumor being, under these circumstances, speedily developed.

Treatment.—The only treatment which can be of any service in cases of tumor of the upper jaw, is extirpation of the growth, which may require the removal, partial or complete, of the superior maxillary and perhaps of the malar bone. In the case of a *non-malignant* growth, springing from the antrum, there can be no question as to the propriety of the operation; and even if the tumor originate behind the jaw, excision, though attended with danger from hemorrhage and from the implication of the base of the skull, may be properly attempted, if the general condition of the patient be favorable to such a procedure. In the case of a *malignant growth*, provided that the glandular implication be not extensive, excision may be properly resorted to, if the case be seen before the tumor has spread beyond the cavity of the antrum; if, however, the soft structures of the cheek be involved, or if the submaxillary glands be much enlarged and indurated, even though the growth be still limited by the walls of the antrum, operative interference is, as a rule, to be avoided; complete extirpation would scarcely be practicable under such circumstances, while a partial removal of the disease could but render the patient's condition worse than before. Lawson has, however, reported a case in which he removed as much of the growth as could be reached, with the implicated integument, and then applied the hot iron, and dressed the wound with chloride of zinc paste; the cauterization was subsequently twice repeated, and the patient ultimately recovered.

FIG. 414.



Excision of the upper jaw. (FERGUSSON.)

Excision of the Upper Jaw.—To Lizars is justly ascribed the credit of having first proposed excision of the whole upper jaw for tumor of the antrum, and to Gensoul (in 1827), that of having first actually performed the operation, though partial excisions had been previously done by Dupuytren, Jameson, of Baltimore, and others. Various incisions are recommended by different surgeons, the best, in my judgment, being that advised by Fergusson, which consists in dividing the upper lip in the mesial line, laying open the nostril corresponding to the side of the tumor, carrying the knife (if more space be necessary) from the root of the ala, between the side of the nose and the cheek, as far as the nasal bone, and then cutting transversely opposite the lower border of the orbit to the zygomatic process of the malar bone. The flap thus marked out being dissected up, sufficient room is afforded for the removal of the largest tumor. Lizars employed an incision from the angle of the mouth across the cheek to the malar bone, supplementing this cut, if necessary, by one through the lip into the nostril, and by a short longitudinal incision at the malar extremity of that first made. Liston's method, which, with various slight modifications, is still often adopted, consists in making one incision from the external angular process of the frontal bone through the cheek to the corner of the mouth; a second along the zygoma, joining the first; and a third from the nasal process of the maxilla, detaching the ala of the nose, and cutting through the lip in the mesial line.

By any of these methods, the whole upper jaw may be readily removed, the flaps being dissected away from the surface of the tumor, and the bony connections of the part severed with a Hey's or other small saw, and strong cutting pliers. One, or, if necessary, two incisor teeth being extracted, the saw may be applied to the alveolus, to the floor of the nostril, or to both, so as to cut a deep groove in which the blades of the cutting forceps may be applied; the hard palate is then cut through with the latter instrument, the soft palate being detached by a transverse incision, or, if practicable, the mucous covering of the roof of the mouth being turned backwards in the form of a flap. The malar bone is next cut across into the spheno-maxillary fissure, or, if this bone is itself to be removed, its orbital and frontal processes, and the zygoma, are similarly divided. Finally, one blade of the forceps is introduced into the nostril, and the other into the orbit (the important structures of the latter cavity being pushed and held out of the way with the handle of a knife or spatula), and the inner angle of the orbit cut across. The tumor may then be grasped with the lion-jawed forceps devised by Fergusson (Fig. 302), and forcibly depressed, the infra-orbital nerve being carefully divided far back, and any remaining attachments severed with a few strokes of the knife. Hemorrhage being arrested by ligation of any vessel that can be reached, or by the application of the hot iron, if necessary, the large cavity that is left may be stuffed with pledgets of lint furnished with a string, to facilitate withdrawal through the mouth, and the external incisions accurately adjusted with the interrupted or twisted suture.

Partial Excision of the Jaw may often, in cases of non-malignant tumor, be advantageously substituted for complete extirpation: thus, if the *orbital plate* be not involved, this may be left, a groove being cut with the saw across the bone below the orbit, and the cutting pliers subsequently applied in the same line; or if, on the other hand, the *alveolus and hard palate* be healthy, the saw may be applied above and parallel to the alveolar border of the jaw, and again in a line perpendicular to this, so as to connect the former section with the orbit; the inner angle of the orbit being then cut across, the upper part of the jaw may be separated with the lion-jawed forceps, as already described. Finally, it may be advisable, in some instances, to adopt Fergusson's suggestion of cutting into the centre of the diseased mass, and working with curved forceps and gouge towards the circumference, instead of undertaking a formal excision. The feeling of surgeons, generally, is unquestionably opposed to these partial operations, the professional mind being probably still influenced by Liston's unqualified condemnation of such "nibbling and grubbing" procedures; as justly remarked, however, by Mr. Heath, it remains to be seen which practice gives the best results. In the case of small tumors, or of necrosis, excision may be sometimes accomplished from within the mouth, without any external incision.

The *results* of excision of the upper jaw are quite as favorable as could be expected, in view of the severity of the operation; 17 cases, quoted by Heath from the *Medical Times and Gazette*, gave 14 recoveries; and 20 cases tabulated by Ohleman, of Bremen, gave 17 recoveries; while 12 cases of partial excision collected by the same writer were uniformly successful. The chief dangers of the operation appear to be from *shock*, from *hemorrhage*, and (if an anæsthetic be used) from *entrance of blood into the air-passages*.

(1.) *Shock* is not as much a source of risk in cases of excision of the jaw merely, as in those cases in which the jaw is removed as a preliminary step in the extirpation of retro-maxillary tumors. It is diminished by the use of chloroform, which, as the hot iron may be required in the latter stages of the operation, should in these cases be substituted for ether, on account of the inflammable nature of the latter agent.

(2.) *Hemorrhage* is always pretty free in these operations, during the early stage, particularly if the incision through the cheek is adopted, when the facial artery is cut at a point at which its calibre is considerable; the surgeon may, if he think proper, apply a ligature to this vessel before proceeding to the other steps of the operation, but, as a rule, the pressure of an assistant's fingers, or the application of a *serre-fine*, will suffice to control the bleeding until the whole excision has been completed. At a later stage of the operation, there is again pretty free bleeding from branches of the internal maxillary, which are necessarily cut or torn across where the jaw is removed; these branches may be secured by ligation, or may be occluded by a few touches of the hot iron, which will often be found a more convenient application in this situation. In order to prevent hemorrhage during the operation, Lizars proposed and practised ligation of the carotid artery, as a preliminary proceeding; this plan is, however, abandoned at the present day, both as unnecessary, and as, in itself, seriously complicating the patient's condition. The tendency of modern surgical writers, indeed, is to speak very lightly of the risk of hemorrhage in excision of the upper jaw, and Prof. Gross, in alluding to this subject, goes so far as to say that "no skilful surgeon now even employs compression of the carotid artery in these operations," and that "there are no structures in the body of the same extent, in their natural and diseased condition, the removal of which is attended with so little hemorrhage." With due diffidence, I must express my dissent from this opinion. I believe that profuse bleeding is a more frequent cause, if not of death, at least of danger, in excision of the upper jaw, than is commonly acknowledged, and consider compression of one or even both carotids, during the operation, a highly proper and judicious precaution. Another plan, which is suggested by Fergusson, may also be adopted with advantage; this is to notch, if not fairly divide, the ascending process of the superior maxilla, with the alveolus and hard palate, before dissecting up the cheek or even cutting into the cheek at all—the most tedious part of the operation being thus accomplished before any incision is made into the most vascular parts. Ligation of the carotid may occasionally be rendered necessary by the occurrence of consecutive or secondary hemorrhage, as in a fatal case under the care of Le Gros Clark, in which Wagstaffe tied the carotid for profuse bleeding occurring on the seventh day, and a successful case recently recorded by W. H. Pancoast, of this city.

(3.) The risk of *suffocation from blood flowing into the air-passages*, during the operation, is of course greater when the patient is in a state of anæsthesia, than it would be if no anæsthetic were employed; and in Mr. Hewett's well-known case,[1] the fatal result was attributed to this cause. To prevent such an occurrence, anæsthesia should not be pushed further than absolutely necessary, and assistants should constantly mop out the mouth with sponges attached to sticks of a suitable length. Nüssbaum, believing that this is the principal source of risk in jaw operations, advises the preliminary performance of a temporary tracheotomy,[1] the glottis to be closed with a piece of oiled lint, and chloroform to be administered through a tracheal tube; this plan has, with various modifications, been adopted by other surgeons, including Little, of New York, and Cheever, of Boston, but, I confess, seems to me rather adapted to complicate than to facilitate the operation, and I can but say the same of Rose's and Burow's suggestion, that the patient's head, during the operation, should be thrown back so far as to allow the blood to flow through the nostrils.

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[1] Med.-Chir. Trans., vol. xxxiv. p. 43.

Excision of the greater part of both Upper Jaws was performed by Rogers, of New York, in 1824, and *complete extirpation* has since been practised by Heyfelder, Maisonneuve, Simon, Carrothers, Brigham, and others; the whole number of operations on record is about two dozen. The incisions for this operation, which is one of the gravest character, consist of a median division of the upper lip, with separation of both nostrils—a duplication, in fact, of the operation recommended for excision of either jaw separately. When portions only of the jaws are to be removed, the surgeon may adopt a plan suggested and successfully employed by Porter, of Boston. This consists in making a Y-incision, the long arm of the Y dividing the upper lip, and the small arms entering the nostrils, which can then be pushed upwards so as to afford a considerable amount of room.

In all operations upon the upper jaw, the skin covering the tumor should be scrupulously preserved, no matter how thin and distended it may appear. To complete the subject of excision of the upper jaw, the following *statistics* of the operation are quoted from Heyfelder.

Nature of operation.	Whole No. of cases.	Cured.	Relapsed or died.	Result unknown.
Complete excision of one jaw, . . .	141	51	33	57
Partial " " " . . .	153	48	35	70
Complete excision of both jaws, . .	11	5	6	...
Partial " " " . .	8	7	1	...

H. Braun has tabulated 23 cases of double excision, classified as follows:—

Nature of operation.	Whole No. of cases.	Recovered.	Died.
Complete extirpation for tumor, ...	11	7	4
Partial or consecutive extirpation for tumor, .	5	5	...
Excision for necrosis, ...	7	6	1

Tumors of the Lower Jaw.—*Cystic, Fibrous, Fibro-cellular, Cartilaginous, Bony, Myeloid*, and *Encephaloid* growths are met with in this situation, commonly originating in the cancellous structure in the centre of the bone, and projecting both into the mouth and downwards into the side of the neck, in the form of rounded or irregularly lobed masses. The remarks which were made as to the importance of a correct *diagnosis*, in cases of tumors of the upper jaw, are equally applicable with regard to those of the inferior maxilla—simple cystic growths being usually readily curable by laying open the cyst and stuffing its cavity with lint—non-malignant, solid tumors requiring excision with saw and cutting pliers—and cancers of this part, on the other hand, often not admitting of any operative interference whatever. Maunder has succeeded in two cases in removing solid tumors of the lower jaw, without making any external incision.

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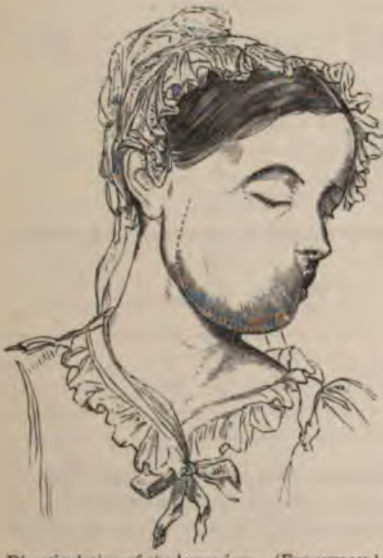
[1] Gluck and Zeller advise that the trachea should be transversely divided between its third and fourth rings a few days before the principal operation, the lower end being fastened externally. The continuity of the windpipe can be ultimately restored by a final operation after convalescence from those which have preceded it. The operation is said to have been successfully performed upon dogs. Trendelenburg and Gerster have devised ingenious *tracheal tampons* for preventing hemorrhage and permitting the administration of an anæsthetic through the tracheal opening.

Excision of the Lower Jaw.—It is occasionally possible, as recently advised by Heath, and as long ago done by the late J. Rhea Barton, of this city, to remove non-malignant solid tumors of the lower jaw, without sacrificing the whole thickness of the bone; and it is certainly desirable, under such circumstances, to preserve the base of the jaw, for the reasons already given in speaking of necrosis of this part. If, however, the whole thickness of the bone on one side be involved, excision may be performed by making a single incision along the base of the jaw, prolonging the cut, if necessary, in a line corresponding to the position of the ascending ramus, and curving the anterior extremity of the wound upwards, toward but not through the prolabium. If the portion of the bone to be removed extend beyond the median line, a ligature should be passed through the tip of the tongue to prevent its retraction when the muscles of the floor of the mouth are divided. In this first incision the facial artery will be cut, and should be immediately secured with ligatures. The flap, formed as above directed, should be carefully dissected up, and the inner side of the jaw cautiously cleared, by separating the soft tissues of the mouth—a tooth having been previously extracted on either side of the tumor; the saw is to be applied so as to cut a deep notch through the alveolus, the bone section being subsequently completed either with the saw or cutting pliers. The part to be removed is then seized with the lion-jawed forceps, and wrenched out, any remaining attachments being severed with a few strokes of the knife.

FIG. 415.



Disarticulation of the lower jaw. (FERGUSSON.)

If the morbid growth involve the angle of the jaw and part of the ascending ramus, it will be necessary to disarticulate the bone upon that side; in this case, the incision should be prolonged to the back of the articulation, when the bone, having been divided in front of the tumor, is to be cleared by careful dissection, the surgeon then depressing the body of the jaw, so as to render tense and facilitate the division of the attachment of the temporal muscle to the coronoid process; the jaw being twisted somewhat outwards, the joint may now be opened from the front, and disarticulation completed. The edge of the knife should, throughout, be kept close to the bone, lest the internal maxillary or even the external carotid artery should be accidentally wounded. Hemorrhage being checked by ligatures, or, if from the dental artery in the cut surface of bone, by the application of Monsel's salt or the actual cautery, the external incision may be closed by means of the interrupted or twisted suture. Until union is completed, the patient's diet should be limited to liquid food, which may be given through a tube. In order to avoid wounding the portio dura nerve or parotid duct, J. L. Lizars, of Toronto, recommends instead of the incision above described, one passing from the commissure of the lips outwards towards the ear, disarticulation being readily effected from within the mouth when its orifice is thus enlarged. As already mentioned, Maunder has reported two cases in which he succeeded in removing large tumors of the lower jaw, without any external incision whatever.

Metallic caps, to fit the teeth of the remaining portions of the jaw, and connected with a spring to a similar contrivance applied to the teeth of the upper jaw, are sometimes employed to prevent distortion from the action of the muscles. Such an apparatus is, however, according to Heath, quite unnecessary, as the bone quickly resumes, unaided, its normal position.

If the tumor be very large, involving both sides of the jaw, a U-shaped incision dividing both facial arteries may be employed, as recommended by Fergusson; or, as advised by Heath, the lower lip may be divided in the median line, and the flaps dissected back on either side.

Excision of a part of the lower jaw for tumor, which was first performed by Deaderick, of Tennessee, in 1810 (though his case was not published until thirteen years later), has been practised a great many times; and, except in cases of malignant disease, with very good results. The proportion of failures under the latter circumstances (twenty-one out of thirty-nine cases, according to Heyfelder) authorizes the question whether, in a case of cancer of this part admitting of any operation, complete extirpation would not be better than any less sweeping measure. The following *statistics* of excision of the lower jaw, *for all causes*, are taken from Heyfelder.

Nature of operation.	Whole No. of cases.	Cured.	Relapsed or died	Result unknown.
Complete extirpation, ...	15	14	1	...
Disarticulation of half the jaw, . .	133	90	43	...
Partial excision, ...	138	84	33	21

Anchylosis or Closure of the Jaws may follow sloughing resulting from the abuse of mercury or from cancrum oris, or occurring in the course of low fevers; it may also be caused by rheumatoid arthritis, by the contraction of the cicatrix of a burn, or by a wound of the temporo-maxillary articulation. If the case be one of actual *anchylosis* (*i.e.* due to articular changes), osteotomy of the ascending ramus should be tried; this operation has, according to Schulten, been employed in nineteen cases with invariably good results. If the closure of the jaws be due to cicatricial contraction, and be confined to *one side*, it may be remedied by a resort to Rizzoli's or Esmarch's operation (see p. 308), the latter procedure being probably the better of the two. The section of the bone should always be made *in front* of the cicatrix. If *both sides* of the jaw are affected, provided that the whole thickness of the cheek be not involved, an attempt may be made to restore the mobility of the part by dividing the cicatricial bands from within, and gradually separating the jaws by means of a screw dilator, or, which Heath prefers, by the use of metal shields adapted to the teeth, and forced apart with wedges. This mode of treatment, though both tedious and painful, can, according to Heath, be made with care and attention to yield very good results. An ingenious arrangement of pulleys and leather straps has been successfully employed by Dr. B. J. D. Irwin, of the U. S. Army. Excision of the condyle of the lower jaw for temporo-maxillary anchylosis has been successfully resorted to by Humphry, Bottini, Little, and Abbe.

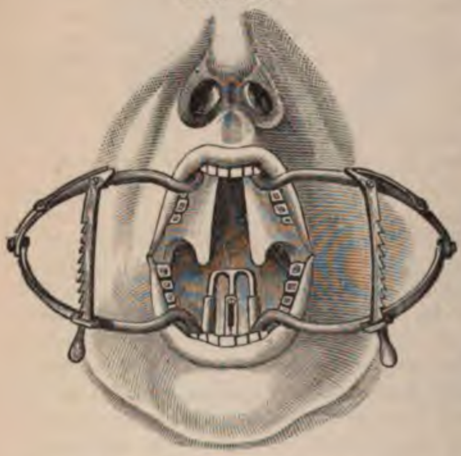
DISEASES OF THE PALATE.

Cleft Palate.—This is a congenital deformity consisting of a division in the median line of the part, which may be confined to the uvula (*Bifid Uvula*), or to that and the soft palate, or may involve the whole roof of the mouth, being, perhaps, additionally complicated by the coexistence of harelip. More rarely, the hard palate is cleft (in connection with harelip), the soft palate and uvula escaping. In some cases, there is a *double* fissure anteriorly, the intermaxillary bone projecting between the two clefts. If the deficiency be extensive, a cleft palate may interfere seriously with deglutition by allowing regurgitation through the nose, and in all cases it causes indistinct articulation, with a disagreeable modification in the tone of the voice.

Treatment.—If very slight, and limited to the soft parts merely, a cure[1] may sometimes be obtained by Cloquet's plan, recently revived by Mason, of repeatedly cauterizing the angle of the cleft, and then waiting for cicatrization to produce contraction. As a rule, however, cleft palate can only be remedied by the use of the knife, the operations applied to the soft palate being called *Staphyloraphy* and *Staphyloplasty*, and that to the hard palate, *Uranoplasty*.

Staphyloraphy.—If the case be complicated with harelip, this should be operated on in infancy, the patient wearing subsequently a suitable cheek-compressor, so as to encourage contraction of the fissure. As the operation of staphyloraphy is both painful and tedious, it was formerly considered necessary to wait until the patient should be old enough to be himself anxious for a cure, and willing to co-operate with patience and fortitude in the surgeon's efforts for his relief. At the present day, however, with the aid of anæsthetics, and particularly with the facility afforded by the use of one or other of the ingenious gags devised by Coleman, T. Smith, Wood, Mason, Whitehead, Weir, and other surgeons, it is no longer thought imperative to wait in all cases until adult life, and numerous highly successful operations upon young children have now been performed under these circumstances. The great object of operating at an early period, in these cases, is that the

FIG. 416.



Whitehead's gag and tongue depressor.

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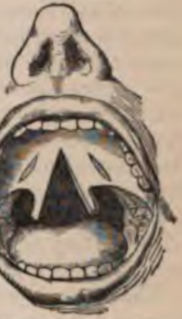
[1] Tuckey recommends *preventive treatment* as in the case of harelip (see foot-note to page 737).

fissure may be closed before the child has acquired the peculiar nasal tone of voice which habitually accompanies the deformity; and the age at which the operation should ordinarily be attempted, in suitable cases, may be given, upon the authority of Holmes, as about three years.

The first successful staphyloraphy was done by Roux, in 1819, and the operation has since been illustrated by the Warrens, father and son, Mütter, Dieffenbach, Liston, Fergusson, Sédillot, Mettauer, J. Pancoast, Avery, Collis, Pollock, and others. In its simplest form, the operation consists in freshening the edges of the cleft, and then bringing them together with a sufficient number of interrupted sutures. In order to diminish the tension upon the stitches, Roux employed transverse incisions, for which Dieffenbach judiciously substituted incisions parallel to the fissure. Warren, in 1843, introduced a further improvement, which consisted in dividing the muscles contained in the posterior pillar of the fauces; but to Fergusson, in 1844, is due the credit of first distinctly pointing out the importance of a preliminary myotomy, so as to temporarily paralyze the velum, and thus prevent disturbance of the line of union by the muscular action of the parts.

Fig. 417.



Sédillot's operation for staphyloraphy.

Fergusson's operation consists in dividing the levator palati on either side, by introducing a curved knife through the fissure and cutting from above—then dividing the palato-pharyngeus by snipping the posterior pillar of the fauces (as was done by Warren), and, if necessary, similarly dividing the anterior pillar, containing the palato-glossus. Pollock and Sédillot divide the levator palati by what might be called a submucous section, thrusting a knife through the palate near the hamular process on either side, and severing the muscular fibres by raising the handle and depressing the blade of the instrument. This division of the muscles is often attended with more bleeding than any other part of the operation, and hence, if chloroform is to be used, may be advantageously postponed, as recommended by T. Smith, until after the introduction of the sutures, or, on the other hand, may be done, as advised by Callender, *without* chloroform, a few days before the rest of the operation is performed.[1]

Paring the edges of the fissure may be either the first or the second step of the operation, according as myotomy has or has not been previously performed. The surgeon may seize the tip of the uvula on either side and pare the edges from before backwards, by transfixing the part with a sharp-pointed bistoury near the angle of the cleft, the angle itself being subsequently freshened; or, as advised by Smith, may cut from behind forwards—the advantage of this plan being that the blood flows backwards, and thus does not obscure the line of incision. Drs. Packard and Cohen, of this city, have adopted with advantage the plan of *splitting* instead of *paring* the edges, as practised by Langenback and Collis in cases of vesico-vaginal fistula, and Dr. Forbes has, in cases of slight extent, ingeniously adapted Nélaton's harelip operation, surrounding the fissure with an inverted Λ incision, the resulting wound becoming, by the dropping of the flap, of a diamond ◊ shape. (See page 738.)

The *introduction of the sutures* is probably the most difficult part of the operation for cleft palate. If the ordinary silk suture is to be used, the plan suggested by Avery will be found very convenient. This consists in introducing, with a small nævus needle, on one side a *single thread*, and on the other side a *loop* of silk: one end of the single thread being then passed through the loop, the latter is withdrawn, carrrying the single thread with it, and thus readily bringing the suture into place. By this mode of proceeding the needle is introduced on either side *from below*, thus enabling the surgeon to regulate the distance between his stitches with greater accuracy than would otherwise be possible. Instead of the silk suture, T. Smith employs fine catgut or horsehair, while most American surgeons consider silver wire preferable to any other material. If wire be used, a short curved needle should be employed, its introduction being facilitated by the use of a suitable handle or forceps. In my own operations I have employed two long-handled needles, one for either side, an assistant threading them with wire through the fissure, after they have been introduced.

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[1] According to Lawson Tait, myotomy by any method is occasionally followed by atrophy of the palate. Willett and Marsh have met with secondary hemorrhage requiring the operation of plugging the posterior palatine canal.

The mode of *fastening the suture* is a matter of some importance: Ferguson passes one end thorough a slip noose formed upon the other, and drawing this noose tight, runs it up so as to approximate the edges of the fissure, securing the whole with an ordinary surgeon's knot. If horsehair be used, a triple instead of the common double knot is, according to T. Smith, necessary to prevent slipping. The wire suture may be secured by clamping upon it a perforated shot. From three to five sutures are usually required, and they should enter and leave the palate about a quarter of an inch from the freshened edge on either side of the cleft; they must not be drawn too tight, it being always remembered that they are meant not to pull, but merely to hold the edges together. The anterior suture is usually introduced first, and when all are secured, if, in spite of the relaxation afforded by myotomy, the parts appear tense, free lateral incisions should be made on either side.

The sutures, as a rule, should not be removed until the eighth or tenth day, and then one or two at a time—the patient during the interval being fed on liquid but nutritious food, and kept as quiet as possible, though not necessarily confined to bed.

After the operation, the voice is occasionally observed to have undergone immediate and decided improvement, but in most cases, at least in adults, a considerable length of time and a long course of vocal gymnastics will be found necessary to restore distinct articulation. The impairment of voice which persists in these cases is, as pointed out by F. Mason, due to the tension of the palate, which forms a curtain tightly stretched across the fauces, while the air enters the posterior nares above; to remedy this, Mason supplements the ordinary operation by severing the attachments of the palate to the fauces on either side.

Staphyloplasty is a name employed by Dr. Schönborn, a German surgeon, for an operation which consists in taking a flap of mucous membrane from the posterior wall of the pharynx, and dove-tailing it between the freshened edges of the palatal cleft; the advantage claimed for this method is that the improvement in voice is greater than after the ordinary operation.

Uranoplasty; Uraniscoplasty.—The merit of first devising an operation for the cure of fissure of the hard palate is due to the late Dr. J. Mason Warren, of Boston, who published an account of his procedure in 1843. His plan was to dissect up, with a long double-edged knife curved on the flat, the mucous covering of the hard palate, beginning on either side of the fissure, and carrying the dissection back to the alveolar processes; the pendulous flaps thus formed were then united in the median line. Another plan, which Fergusson prefers, is to make an incision parallel to the alveolus on either side, and carry the dissection towards the free margin of the fissure.[1] Langenbeck uses a blunt instrument with which to separate the periosteum from the bone, in order to take advantage of the osteo-genetic power of that membrane; and his operation, which has been frequently performed in Germany, has been successfully repeated in this country by several surgeons, myself included. Dr. Wm. R. Whitehead published an excellent paper on this subject, with an analysis of 55 cases, in the *American Journal of Medical Sciences* for October, 1868. Fergusson, reviving a suggestion of Dieffenbach's, has proposed, as an improvement upon Langenbeck's method, to divide the hard palate on either side with a chisel, and then forcibly press and wire the segments together so as to diminish the median fissure. Eighty-two cases had thus been treated by Sir Wm. Fergusson up to the end of 1875, and, with some few exceptions, with very remarkable success. Woakes has modified this operation by partially sawing through the palate from the nostril, and then bending the bones into the required position.

It is a disputed point amongst surgeons, whether, in dealing with a fissure of both hard and soft palate, an attempt should be made to close the whole gap at once, or whether the operation should be divided between several sittings: no positive rule can be given upon this point, but Holmes's advice appears judicious, viz., to be content with closing a portion of the hard palate at the first operation, provided that the parts come easily together, but, if it should be found necessary to detach the soft parts through the whole extent of the cleft, then to attempt complete closure at one operation. According to T. Smith, if *staphyloraphy* be performed at an early age, the fissure of the hard palate will subsequently undergo contraction to such an extent as to render it possible, in most cases, to dispense with any further operation.

In cases of cleft palate not admitting of surgical treatment, and in most cases of *Acquired Perforation of the Hard Palate*, particularly as the result of syphilis, *obturators* of metal, ivory, or vulcanized India-rubber, may be worn; one of the best instruments of the kind is that devised by Kingsley, of New York; it is provided with a soft curtain of India-rubber, to take the place of the natural velum. A judicious caution as to the use of obturators, in cases of necrosis, is given by Heath. This is, that no plug should be introduced into the aperture itself, which would inevitably become still further enlarged by the pressure on its edges, but that the occluding apparatus should consist of a properly fitting plate, arching below the palate, and attached to the teeth.

Elongation of the Uvula.—This affection is usually remediable by the use of astringent gargles or caustic solutions, but, if persistent, may require a surgical operation for its relief. This operation consists simply in cutting off the pendulous part with scissors, at about a third of an inch from the root of the organ. The tip of the uvula may be seized with forceps held in the left hand, while the scissors are applied with the right, or an instrument may be used which has been constructed for the purpose, and by which the part to be removed is caught and cut off at the same moment. (Fig. 418.)

Tumors of the Palate.—*Adenoid, fibrous*, and *cartilaginous* tumors of the palate have been observed by Nélaton, Marjolin, Laugier, Watson, King, Bickersteth, Dobson, Eliot, and other surgeons. As the growths increase in size, they affect the tone of the voice, and ultimately interfere with deglutition; the *treatment* consists in enucleation, which is usually readily effected with the finger introduced through an incision corresponding to the long axis of the tumor. In Watson's and King's cases it was thought necessary to facilitate access to the tumor by a preliminary section of the lower jaw. Méplain reports a case of *mucous polypus* of the palate successfully treated by the injection of acetic acid.

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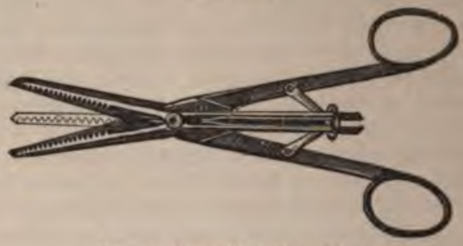
[1] Lannelongue reports a case successfully treated by detaching and bringing down the *nasal* mucous membrane.

FIG. 418.



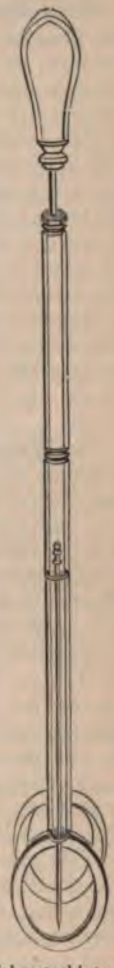
Forceps-scissors for cutting uvula.

DISEASES OF THE TONSILS.

Tonsillitis, *Inflammation of the Tonsils,* or *Quinsy,* may terminate in resolution, or may run on to suppuration—in which case the patient may suffer a good deal from dyspnœa, before relief is afforded by the spontaneous opening of the abscess. Local depletion, by scarification of the part with a probe-pointed knife, may sometimes be of service in these cases, and, if the presence of pus can be determined, an incision may be made for its evacuation; the ordinary gum lancet is a safe and convenient instrument for this purpose. Giné and Armangué advise applications of bicarbonate of sodium, which they consider almost a specific in this affection. In *diphtheritic* tonsillitis, Menzel has derived advantage from the injection into the gland of a few drops of the liq. iodinii compositus.

Chronic Enlargement or Hypertrophy of the Tonsils may occur in healthy children as the result of frequent attacks of tonsillitis, croup, diphtheria, etc., or may be a manifestation of the scrofulous diathesis, occurring without any obvious exciting cause. If excessive, this hypertrophy may lead to unpleasant results, such as snoring during sleep, obstruction to nasal respiration (giving rise to a habit of keeping the mouth open), and even permanent dyspnœa—producing perhaps contraction of the chest, and eventually interfering with the general nutrition of the patient. Deafness, also, is often attributed to tonsillar enlargement. The *treatment* consists in the use of astringent gargles, the application of nitrate of silver, in substance or solution, the muriated tincture of iron, or the tincture of iodine (which Dr. Dabney advises should be combined with ergotine and glycerine), and in the adoption of means to improve the general health. Inhalations of diluted creasote vapor, or the use of the atomizer, may also prove of service. Krishaber recommends ignipuncture with Paquelin's cautery. As a last resort, excision of a portion of the enlarged tonsil may be performed, either by seizing the projecting part with forceps and cutting off a slice with a probe-pointed bistoury, wrapped so as to protect the lips, or by means of an instrument devised for the purpose by Fahnestock, and since modified by others, which is known as a *tonsillotome* or *tonsil guillotine*. If the simple knife be used, care should be taken to keep its edge directed somewhat towards the median line, so as to avoid the possibility of wounding the internal carotid artery. J. Wood advises that the section should be made from below upwards. The surgeon may stand behind the patient in operating on the right tonsil, and to the patient's right side in operating on the left. Hemorrhage is rarely troublesome after these operations, usually yielding readily to the application of ice or simple astringents; if bleeding should, however, persist, a turpentine gargle, as advised by Erichsen, might be tried, or the part might be lightly touched with a brush or sponge dipped in Monsel's solution. Panas recommends digital compression through the mouth, with counterpressure externally.

FIG. 419.



Fahnestock's tonsillotome.

Malignant Affections of the Tonsils.—The tonsil is occasionally, though rarely, the seat of cancer, which may be either scirrhus or encephaloid, the latter being (according to Poland, who has particularly investigated the subject) the commoner form of the disease; epithelioma, also, is said to have been observed as a primary growth in this locality. The diagnosis from *simple hypertrophy* may be made by observing the greater hardness of the tumor, its tendency to ulceration, and the implication of neighboring lymphatic glands. From *syphilitic disease* of the tonsil, the diagnosis is sometimes very difficult, but may be aided by observing the efficacy, or want of efficacy, of anti-syphilitic treatment. In most cases of malignant disease, in this situation, palliative measures are alone applicable, but if the nature of the affection is recognized at an early period, while the disease is as yet confined to the tonsil itself, *excision* may be properly attempted. Extirpation from within the mouth has been practised by Velpeau, Warren, and Demarquay—the latter surgeon having employed the *écraseur*—but, upon the whole, the operation by external excision, as successfully resorted to by Cheever, of Boston, would appear preferable. In the case recorded by this surgeon, two incisions were made, one from within the angle of the jaw downwards, in a line parallel to the sterno-mastoid muscle, and the other along the lower border of the jaw; by dissecting away the parts on either side, an enlarged lymphatic gland was first exposed and removed, and then, the digastric, stylo-hyoid, and stylo-glossus muscles being cut, the fibres of the superior pharyngeal constrictor were separated, so as to allow the finger to enter the pharynx, when the tonsil was readily enucleated. The largest vessel divided was the facial artery, twelve ligatures in all being required. The transverse wound was closed with a single suture, and recovery was complete in about a month.

DISEASES OF THE PHARYNX AND ŒSOPHAGUS.

Erysipelas of the Pharynx is occasionally met with, either as a primary affection, or as a complication in cases of ordinary facial erysipelas; the *treatment* consists in the administration of tonics and stimulants, with the local use of a solution of nitrate of silver, and of gargles of chlorate of potassium. Should sloughing occur, the mineral acids may be employed, both internally and topically. Laryngotomy may become necessary in the event of the sudden supervention of œdema of the glottis, while free incisions into the affected parts would be indicated by the occurrence of suppuration.

Retro-Pharyngeal Abscess.—Abscesses are occasionally met with behind the pharynx, originating either in the areolar tissue in front of the vertebral column, or in the lymphatic glands which exist in that situation. The formation of pus in some cases evidently depends upon disease of the cervical vertebræ. Retro-pharyngeal abscess is commonly a grave affection, 41 out of 97 cases collected by Gautier having proved fatal, though Bokai reports 144 cases observed by himself, of which only 11 terminated in death. No age is exempt from the disease, though it is most common among young children. The early symptoms are in no wise distinctive, but when pus has formed, a distinct tumor may be observed, by the touch if not by sight, usually involving one side of the pharynx only, and soon leading to unilateral swelling of the neck, and often to stiffness of the lower jaw. The *treatment*, which should be promptly applied to prevent suffocation, consists simply in making a free opening (preferably through the mouth) for the evacuation of the pus, either with a wrapped bistoury, a trocar and canula, or an instrument devised for the purpose and known as a pharyngotome.

Pharyngeal Tumors may arise in the post-pharyngeal areolar tissue, may descend from the nasal cavities, or may spring from the epiglottis. They may be of the nature of polypi (fibrous or fibro-cellular tumors, myxomata, etc.), or may be malignant growths, either of a sarcomatous,[1] cancerous, or epitheliomatous nature. As they increase in size, they impede both deglutition and respiration, and may thus lead directly to a fatal termination. Operative interference, further than tracheotomy to avoid suffocation, can rarely be justified in a case of malignant growth in this situation (though extirpation of the pharynx for cancer has been recommended and practised by Langenbeck and Billroth), but the treatment of innocent pharyngeal tumors may be more hopefully undertaken. In some cases, it may be possible to remove the mass through the mouth by avulsion or enucleation, or by the use of the ligature, *écraseur*, galvanic cautery, etc., but in dealing with growths springing from the epiglottis or adjoining parts, such a course would rarely be practicable, and under these circumstances the operation known as *Sub-hyoidean Pharyngotomy* might be properly performed.

This process appears to have been first described by Malgaigne, under the name of *Sub-hyoidean Laryngotomy*, and has been recently revived by Langenbeck. In a case narrated by this surgeon, a preliminary tracheotomy having been performed and a tube introduced, the operator made a small transverse incision, close beneath the lower edge of the hyoid bone, and divided the sterno-hyoid and omo-hyoid muscles. The thyro-hyoid membrane being opened, the finger of an assistant was placed in the pharynx, pushing forward the tumor for the removal of which the operation was undertaken, when the mucous membrane of the gullet was divided, and the epiglottis, which was found to be healthy, drawn forward with a strabismus hook. The tumor—a fibro-myxoma, the size of a pigeon's egg—was now seen arising from the left aryteno-epiglottic fold, and extending by a broad base to the left side of the pharynx. Excision was accomplished by drawing out the growth with forceps, and carefully separating it from its attachments, blood being kept from entering the larynx by pressing a sponge over the glottis. For several weeks it was necessary to feed the patient through a tube, but the ultimate result of the case was quite satisfactory. This operation has also been successfully employed by Baum, in a case of round-celled sarcoma, and by Lefferts, in a case in which a foreign body had been fixed in the larynx for four years.

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[1] See interesting papers by Dr. F. I. Knight, of Boston, in *St. Louis Medical and Surgical Journal*, Sept. 1879, and by Dr. G. A. Peters, of New York, in *Medical Record*, Nov. 20, 1880.

Spasm of the Œsophagus, or, as it is often called, *Spasmodic Stricture* of this tube (*Œsophagismus*), may be met with in connection with other hysterical phenomena, or may be a reflex condition depending upon slight inflammation or ulceration of the part, upon hepatic disease, upon the irritation caused by hemorrhoids, etc. The *diagnosis* from actual obstruction may be made by observing the intermittent character of the affection, and by the use of the œsophageal bougie, which, in a case of this description, will meet with little if any resistance. According to Hamburger and Mackenzie, information may also be gained by auscultation of the œsophagus, regurgitation of food, etc., being heard to take place instantly in cases of spasm, but after an appreciable interval in cases of organic stricture. The *treatment* consists in removing any source of reflex irritation which can be detected, and in the administration of tonics, antispasmodics, and laxatives, with the use of cold bathing, and attention to the quality of the food, which should be unirritating and thoroughly masticated. Girard recommends hypodermic injections of atropia.

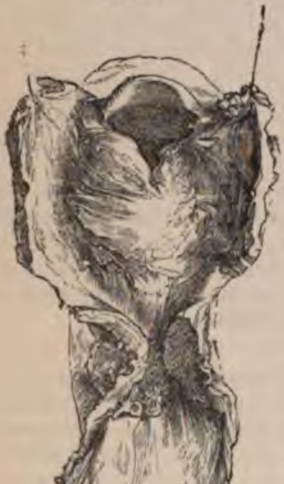
Paralysis of the Œsophagus may occur as a symptom of disease of the central nervous system, and may be distinguished from œsophageal spasm by the absence of pain or any sense of choking. Food may be cautiously administered in these cases through a stomach-tube, or the strength of the patient may be sustained by the use of nutritive enemata. The application of electricity is said to have occasionally proved beneficial.

A Dilated and Sacculated Condition of the Œsophagus is sometimes met with—usually, however, as a consequence of organic stricture. A comparatively slight degree of obstruction, and one which does not prevent the passage of a bougie, may yet allow the temporary retention in the gullet of a portion, at least, of the food swallowed, and thus gradually lead to dilatation of the part, and the formation of pouches extending among the muscles of the neck in various directions. Such a condition existed in the case of the late Dr. Marshall Hall. The *treatment* of œsophageal dilatation, without stricture, can be palliative merely, consisting in the administration of liquid food through a tube, or in the use of nutrient enemata.

Stricture of the Œsophagus.—Dysphagia, which is the prominent symptom of œsophageal obstruction, may depend upon a number of conditions totally independent of any organic disease of this part. Thus, as has been already mentioned, difficult deglutition may be due to the existence of enlarged tonsils, of pharyngeal tumors, or of retro-pharyngeal abscess; it may also be caused by various affections of the larynx, by the pressure of cervical or intra-thoracic tumors, by aneurism of the carotid, innominate, or aorta, by displacement of the sternal extremity of the clavicle, or by the presence of a foreign body. Hence, the diagnosis of stricture of the œsophagus should only be made after a careful investigation of the history of the case, and of all its circumstances; and the surgeon should beware of hastily thrusting in a bougie, which, if it might, by perforating the wall of an abscess, effect a cure, would, if it should perforate the sac of an aneurism, as certainly cause death.

Varieties of Stricture.—Apart from the condition known as *spasmodic stricture*, which has already been referred to, we may recognize two varieties of the disease, the *fibrous* and the *malignant*. The *fibrous stricture* is usually due to traumatic causes, especially the contact of hot water, or of caustic alkalies or acids, but is also said to have been occasionally observed as a lesion of constitutional syphilis. It may occur in any part of the tube, and varies in extent from a few lines to several inches, involving sometimes a part only, and sometimes the whole calibre, of the gullet. The œsophagus above the seat of stricture is usually dilated, and often ulcerated, that portion which is below being normal, or slightly contracted. The *malignant stricture* is due to the presence of a cancerous (usually scirrhous) or epitheliomatous deposit, which forms a more or less distinct tumor, and is often recognizable by external examination. The rational symptoms of these two forms of stricture are much the same; in both there is gradually increasing difficulty in deglutition, which culminates at last in total inability to swallow—food of all kinds being arrested at the point of obstruction, and ultimately rejected by vomiting after a longer or shorter interval. The diagnosis between fibrous and malignant stricture may, however, usually be made by investigating the etiology and previous history of the case, and by exploration with a gum-elastic bougie, or ivory-headed probang. The sensation given to the surgeon by the passage of the instrument through the stricture differs according to its nature: thus a fibrous stricture is felt to be smooth and evenly resisting, and the withdrawal of the bougie is unattended with bleeding, whereas a malignant growth gives the sensation of a rough and ulcerated surface, and a discharge of pus and blood is apt to follow the exploration.

FIG. 420.



Stricture of the œsophagus. (DRUITT.)

Treatment.—The treatment of stricture of the œsophagus is very unsatisfactory. The strength of the patient must be maintained by the administration of liquid or finely chopped food, and, if necessary, by the employment of the stomach-tube, or the use of nutritive enemata. If the stricture be of a *fibrous* character, temporary advantage, at least, may be often gained by the cautious use of bougies of gradually increasing size; by the employment of fluid pressure, applied by means of a flexible catheter surrounded with a tube of vulcanized India-rubber, which can be distended with air or water after introduction; or by the use of an ingenious instrument recently described by Dr. Morrell Mackenzie under the name of *œsophageal dilator*, which acts much on the principle of Holt's instrument for stricture of the urethra. Instruments for the dilation of œsophageal strictures have also been devised by Fletcher and Wakley, but seem to be inferior to that of Dr. Mackenzie. Krishaber recommends the introduction of a canula through the nostril, and its retention in the œsophagus, so as to effect "continuous dilatation," as is done in stricture of the urethra. Durham also advises the retention of the canula, but prefers to introduce it by the mouth. The application of caustic, as recommended by Home and others, is seldom resorted to at the present day. Internal section of the strictured part of the œsophagus, by means of an instrument consisting of a shaft with concealed blades, which can be protruded after introduction, has been practised by Maisonneuve, Lannelongue, Demous, Studsgaard, Schiltz, Mackenzie, Roe, Elsberg, Dolbeau, Trélat, and Tillaux, the first-named surgeons dividing the stricture from above downwards, and the latter from below upwards. Seven cases operated on by the former method gave but two recoveries and five deaths, while four cases operated on by the latter method all terminated favorably. Great caution must, however, be exercised in using any of these instruments; Demarquay and Bidan record cases in which attempts at catheterization of the œsophagus proved fatal from the passage of the bougie through the œsophageal wall into the bronchi or pleural cavity.

If the stricture be of a *malignant* character, the use of bougies, or other means of dilatation, will in most instances be rather prejudicial than advantageous; the bougie may, indeed, be cautiously employed, as a palliative measure, in the early stages of the disease, but after the establishment of ulceration can scarcely be expected to be of much benefit. Under these circumstances the best that can be done is probably to sustain the strength of the patient with nutritive enemata, and to relieve his sufferings by the free use of anodynes; excision of the affected part is said to have been successfully performed by Czerny, Kolaczek, and Caselli, but three cases in which the operation was resorted to by Langenbeck all terminated fatally, as did one in which Billroth removed the pharynx, larynx, and thyroid gland. Fatal excisions of the pharynx are also attributed to Koenig and Gussenbauer. Thiersch advises the performance of a preliminary gastrostomy. Tracheotomy may sometimes be required to prevent suffocation in the latter stages of the disease.

It occasionally happens that, even in a case of non-malignant stricture, the passage is so tightly occluded that the smallest instrument cannot be introduced, and the patient is in consequence reduced to a state in which death from starvation is imminent. Under such circumstances it has naturally been suggested that an opening should be made into the alimentary canal below the seat of stricture, and a fistulous orifice thus established, through which the patient might be fed; and it has been reasonably argued that though such an operation might not be justifiable in a case of *malignant* disease, from which the patient must inevitably perish at no remote period, yet that in a case of impermeable *fibrous* stricture, the circumstances would be altogether different. The operations which have been performed in these cases are *gastrotomy*, or, as Sédillot, its introducer, has more accurately termed it, *gastrostomy*, and *œsophagotomy*, or, as it is now called by analogy, *œsophagostomy*.

Œsophagostomy, or Œsophagotomy for Stricture, is manifestly best adapted to cases in which the obstruction is in the uppermost part of the tube, and unfortunately the stricture usually extends to such a point as to prevent the surgeon from reaching the œsophagus below it. In a suitable case, however, the operation may be tried, the necessary incisions being those described in speaking of œsophagotomy for the removal of foreign bodies (p. 363), though the procedure, in the case of stricture, would, of course, be more difficult on account of the impossibility of introducing an instrument into the gullet as a guide upon which to cut. If the stricture were of a non-malignant character, it might be proper to attempt a radical cure by extending the incision through the contracted part, as in the analogous operation of external urethrotomy. Œsophagotomy for stricture appears to have been suggested by Stoffel, but was first practised in a case recorded by Taranget, whose patient survived sixteen months. The operation has since been repeated in a good many instances, the whole number of cases to which I have references being 27. Of these, 6 were so far successful that the patients' lives were prolonged for three months or more, while the remainder terminated fatally at an earlier period. The mortality of the operation is thus 77.7 per cent. This record is certainly far from encouraging, but, as will be presently seen, is somewhat more so than that of gastrostomy—and as the operation, though difficult, is not necessarily dangerous, it may, I think, be looked upon as a legitimate surgical resource.

Cases of Œsophagostomy.

No.	Reporter.	Result.	No.	Reporter.	Result.
1	Billroth,	Recovered.	15	Ogston,	Died.
2	Id.	Died.	16	Packard,	"
3	Bruns,	"	17	Poinsot,	"
4	Id.	"	18	Podrazki,	"
5	Bryk,	Recovered.	19	Richet,	"
6	Cohen,	Died.	20	Schede,	"
7	De La Vacherie,	"	21	Id.	"
8	Evans,	"	22	Studsgaard,	Recovered.
9	Holmer,	"	23	Taranget,	"
10	Horsey,	"	24	Watson,	"
11	Kappeler,	"	25	Weinlechner,	Died.
12	Id.	"	26	Id.	"
13	Menzel,	"	27	Willett,	"
14	Monod,	Recovered.			

Gastrostomy is, as its name implies, an operation designed to establish an *artificial mouth*, communicating directly with the stomach. Its performance is naturally suggested by observation of the success with which gastric fistulæ can be established in the lower animals, of the recoveries with persistent fistulæ which are occasionally met with after penetrating wounds of the stomach, and of the remarkable success which has attended *gastrotomy*, or gastric section for the removal of foreign bodies (see p. 383). Sédillot, who first performed the operation, recommends a crucial incision on the left side of the abdomen, over the gastric region; the peritoneal cavity being opened, the surgeon feels for the left border of the liver, which is the guide to the stomach, and having reached the latter organ, draws it forwards with forceps, and fixes it in the wound by perforating the gastric wall with a steel-pointed ivory cylinder, secured externally on a disk of cork; after some days, when adhesions have formed, an opening is made into the middle of the stomach, at a point equidistant from either curvature, and from either extremity. Forster, Durham, Verneuil, and others, prefer a single incision in the line of the left linea semilunaris, open the stomach immediately, and stitch the margins of the aperture closely to the abdominal parietes. Verneuil and Bryant insist that the gastric opening should be a small one. No attempt should be made to introduce food into the stomach until several days after the operation, lest primary union should be interfered with.

Gastrostomy appears to have been performed in about 97 cases, of which 19 are said to have recovered, at least temporarily, while 76 seem to have proved fatal in periods varying from a few hours to three months. The mortality of terminated cases would, according to these figures, be exactly 80 per cent.

Cases of Gastrostomy.

No.	Reporter.	Result.	No.	Reporter.	Result.
1	Albert,	Recovered.	50	Lannelongue,	Died.
2	Bradley,	Died.	51	Le Dentu,	“
3	Bryant,	Recovered.	52	Littlewood,	“
4	Id.	“	53	Lowe,	“
5	Id.	Died.	54	Lucke,	“
6	Id.	“	55	Lutz,	Recovered.
7	Buchanan,	“	56	McCarthy,	Died.
8	Callender,	“	57	MacCormac,	“
9	Clark,	“	58	McGill,	?
10	Courvoisie,	“	59	Id.	Died.
11	Croly,	“	60	Mackenzie,	“
12	Curling,	“	61	Marshall,	Recovered.
13	Davies-Colley,	Recovered.	62	Mason,	Died.
14	Id.	Died.	63	Maunder,	“
15	Durham,	“	64	Maury,	“
16	Elias,	Recovered.	65	Moeller,	“
17	Escher,	Died.	66	Moore,	“
18	Fenger,	“	67	Morris,	“
19	Forster,	“	68	Prewitt,	“
20	Id.	“	69	Pye-Smith,	Recovered.
21	Fox,	“	70	Reeves,	Died.
22	Golding-Bird,	Recovered.	71	Id.	“
23	Id.	Died.	72	Riesel,	“
24	Id.	“	73	Rose,	“
25	Id.	“	74	Id.	“
26	Gritti,	“	75	Rupprecht,	“
27	Heath,	“	76	Schoenborn,	“
28	Herff,	Recovered.	77	Sédillot,	“
29	Hjort,	Died.	78	Id.	“
30	Howse,	Recovered.	79	Sklifosovski,	“
31	Id.	Died.	80	Smith,	“
32	Id.	“	81	Staton,	Recovered.
33	Id.	“	82	Studsgaard,	“
34	Id.	“	83	Swain,	?
35	Jackson,	“	84	Tay,	Died.
36	Jacobi,	“	85	Tiling,	“
37	Jessop,	“	86	Trendelenburg,	Recovered.
38	Jones,	“	87	Id.	Died.
39	Id.	“	88	Id.	“
40	Id.	“	89	Troup,	“
41	Jones (Manchester)	Recovered.	90	Verneuil,	Recovered.
42	Jouon,	Died.	91	Volkmann,	Died.
43	Kraske,	“	92	Von Thaden,	“
44	Krönlein,		93	Weinlechner,	“
45	Küster,	“	94	Id.	“
46	Langenbeck,	Recovered.	95	Whitehead,	Recovered.
47	Langenbuch,	“	96	Williams,	Died.
48	Id.	Died.	97	———	“
49	Langton,	“			

Note.—In Maunder's case, after the patient's death, it was found that the colon had been opened instead of the stomach; Golding-Bird attempted the operation in a fifth case, but was obliged to abandon it uncompleted.

Enterostomy, or an operation designed to provide an opening for the introduction of food into the small intestine, has been suggested by Surmay, a French surgeon, and has been practised on the human duodenum by Langenbuch, with, however, a fatal result.

Gastro-Enterostomy, an operation designed to establish an opening between the stomach and small intestine, in cases of pyloric obstruction, has been practised by Wolfler and Billroth; in the former's case successfully, but in the latter's with a fatal termination.

Introduction of the Stomach-Tube.—This may be required in cases of narcotic poisoning, in which vomiting cannot be excited, or as a means of administering fluid nutriment, in cases in which the patient cannot or will not swallow. The tube is introduced in the same manner as an œsophageal bougie, and the following description will apply to the use of either instrument. The patient is placed in a sitting posture with the head thrown backwards, so as to bring the mouth and gullet as nearly as possible into the same line; the mouth being held widely open (by means of a gag, if necessary), the surgeon passes the tube, previously warmed and oiled, directly backwards to the pharynx without touching the tongue, and guiding the instrument over the epiglottis with the forefinger of the left hand, cautiously presses it onwards into the stomach. If any obstruction be met with, the instrument should be slightly withdrawn and then again pushed forwards, very gently, however, lest the œsophageal wall should be perforated. When food is to be introduced into the stomach, the surgeon may employ a small gum-elastic bag, provided with a nozzle which closely fits the projecting portion of the tube; when it is designed to wash out the stomach, a pump is required, by which one or two pints of tepid water may be injected and a less quantity immediately pumped out again, the process being repeated until the returning fluid is colorless: the object of not completely emptying the stomach at once, is to prevent the mucous coating of the organ from being sucked into the orifice of the tube and thus lacerated.

The risk of passing a stomach-tube into the *trachea* instead of the *œsophagus* is not entirely imaginary, as is shown by cases in which, after death, food and medicines have actually been discovered in the lungs.

DISEASES OF THE AIR-PASSAGES.

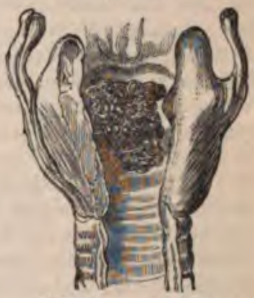
Laryngitis, Tracheitis, Croup, Diphtheria, and other affections involving the larynx and trachea, are commonly treated by the physician, and are described in works on the Practice of Medicine. These diseases are chiefly interesting to the surgeon on account of the necessity which occasionally arises for a resort to the operation of laryngotomy, or to that of tracheotomy, the comparative merits and modes of performing which have been already sufficiently discussed in a previous portion of the volume (pp. 357–361). The results of tracheotomy for diphtheria, in this country, have, I believe, not been very favorable, but the statistics of Wilms, of Berlin, show 103 recoveries in 335 cases, a proportion of nearly 31 per cent.

Abscess of the Larynx is a rare affection which has been well described by Parry, of this city, and by Stephenson, of Edinburgh; the *treatment* consists in making an early incision, and preferably in the median line of the neck.

Prolapse of the Laryngeal Sac, causing partial occlusion of the glottis, has been observed by Cohen, of this city, and was relieved by insufflation of astringent powders.

Tracheocele, or hernia of the lining membrane of the trachea, is a rare affection which has recently been well described by Devalz, of Bordeaux. It appears to originate from violent and repeated attacks of coughing, and is chiefly interesting from the likelihood of its being mistaken for goitre; it admits of no treatment.

Fig. 421.

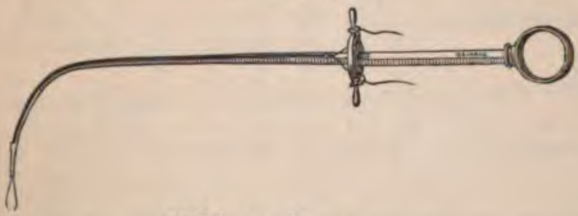


Epithelioma of larynx. (Erichsen.)

Tumors, Warts, or Polypi of the larynx are sometimes met with, belonging usually to the fibro-cellular, papillary, or epitheliomatous varieties of tumor. They produce hoarseness, aphonia, croupy cough, and dyspnœa, the difficulty of breathing recurring paroxysmally, and eventually causing death by suffocation. A flapping sound may often be heard as the tumor moves up and down in the act of breathing, and, by the use of the laryngoscope, the size and position of the morbid growth may be sometimes accurately determined.

Treatment.—In any case in which respiration is or has been at any previous time seriously embarrassed, there should be no delay in opening the trachea and inserting a tube; for experience shows that fatal dyspnœa may in such a case supervene at any moment, and, besides, a preliminary tracheotomy will greatly facilitate any operation for the removal of the tumor. Various plans may be adopted in dealing with the new growth itself: thus an attempt may be made to extract it by means of a *wire snare* or *écraseur* (Fig. 422), as has been successfully done by Walker, Gibb, Johnson, and others; or delicate *laryngeal forceps*, as advised by Mackenzie, may be used to twist off or crush the tumor; or, if too firmly attached, this may be cautiously excised with the *knife, scissors,* or "*laryngeal guillotine,*" or may be severed by the application of the *galvanic cautery;* simple *puncture* may suffice in the case of a cystic growth, while in other instances a cure may perhaps be effected by the repeated application of *nitrate of silver* in substance or solution. The latter mode of treatment may also be employed to prevent repullulation of the tumor after extirpation. In all of these methods, the application of the instrument should be guided by the use of the *laryngoscope.* Voltolini has removed soft polypi by simply swabbing out the larynx with a sponge attached to a flexible wire. To facilitate treatment by any of the above plans, Eysell suggests that the tumor should be pushed upwards by means of a needle introduced from below in the median line of the trachea.

Fig. 422.



Gibb's laryngeal écraseur.

Rossbach introduces a delicate knife in the median line of the thyroid cartilage, and, guiding its movements by the aid of the laryngoscope, removes the growth by cutting from below. To render the larynx less sensitive, Türck and Schrotter advise the successive application of chloroform and of a saturated solution of acetate of morphia. Another method is to open the crico-thyroid membrane and divide the thyroid cartilage, so as to expose the interior of the larynx and allow free excision of the morbid growth with knife or scissors: this operation appears to have been first successfully performed by Ehrman, and has since been repeated by Holthouse, Holmes, Durham, Buck, Sands, Cohen, Czerny, and others. Krishaber, of Paris, has recently recommended, under the name of *Restricted Thyroideal Laryngotomy*, an operation in which the thyroid cartilage alone is divided in the median line, this incision being in his opinion ample for the removal of polypi situated in the ventricle of Morgagni; the vocal cords are not interfered with, and the voice is consequently uninjured by the operation, which is in this respect decidedly preferable to that of Ehrman. Finally, in some cases, Malgaigne's operation, described at page 766, under the name of *Sub-hyoidean Pharyngotomy*, or Langenbuch's modification in which the larynx is opened *below* the epiglottis (*true sub-hyoidean laryngotomy*), may perhaps be preferred to any other.

Dr. Sands has tabulated 50 cases of laryngeal tumor treated by operation; in 11 the growth was removed by external incision, and in 9 of these the patients recovered; in 39 cases the tumor was removed by the mouth, and recovery followed in 38. The operation was performed with the aid of the laryngoscope in 34 cases. Still more extended statistics have been published by Mackenzie and Durham, those of the former author showing conclusively that, when applicable, *laryngoscopic treatment* is much preferable to the operation by external incision. The following table is condensed from Durham's article in *Holmes's System of Surgery*, and from a paper by the same writer in the*Medico-Chirurgical Transactions*, vol. lv.

Operation.	Whole number of cases.	Completely successful.	Partially successful.	Unsuccessful.	Died.	Not terminated.
Application of caustics, etc., .	16	12	4	...	...	—
Forceps, ...	37	33	3	...	1	—
Wire snare, ...	32	28	3	...	1	—
Galvanic cautery, ...	5	3	2	...	...	—
Excision, ...	20	14	5	...	1	—
Puncture, ...	4	4	...	...	...	...
Operation by external section,	40	22	7	7	2	2

Extirpation of the Larynx has been performed on several occasions, usually for papilloma or some form of malignant disease, though Heine has also excised the anterior portion of the larynx for chronic thickening of the cartilage. Langenbeck has excised not only the entire larynx, but the hyoid bone, and portions of the tongue, pharynx, and œsophagus; Caselli the larynx, pharynx, and base of the tongue; and Billroth the larynx, pharynx, and thyroid gland. Lefferts has collected 19 cases of extirpation of the larynx, of which 13 terminated fatally, but Ceccherelli gives a more favorable view of the procedure, 20 out of 30 cases collected by this author having recovered at least from the immediate risks of the operation. *Unilateral* excision of the larynx, pharynx, hyoid bone, and base of tongue, has been successfully practised by Gerster, of New York.

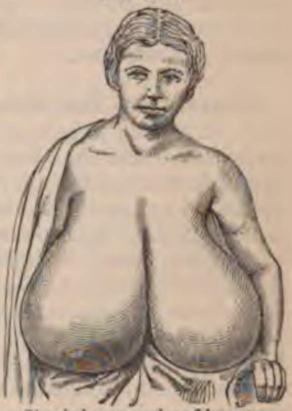
Stricture of the Trachea has been already referred to at page 350.

CHAPTER XXXIX.

DISEASES OF THE BREAST.

Hypertrophy of the Breast may occur during the early months of pregnancy (when it may disappear spontaneously after confinement), or may be met with in young girls, originating usually at the period of puberty, and increasing until the bulk and weight of the enlarged gland prove a source of great inconvenience, and even of suffering. Labarraque has collected 32 cases of this affection, in one of which (Durston's) the enlarged breast attained the enormous weight of 64 pounds. Both mammæ are commonly affected, though not to the same extent. The *treatment* of this affection is usually unsatisfactory. Local applications of belladonna and iodine, with compression, may be tried, while attention is given to the state of the patient's general health, and to the removal of any uterine disorder that may be present. As a last resource, excision of the hypertrophied mass may be employed, but the operation should be reserved for extreme cases. Occasionally the removal of one hypertrophied breast has been followed by rapid diminution in the size of the other, and recovery of the patient. Hence, though both mammæ be enlarged, only one should be removed at first, in hope that the other may return to its normal condition. The enlargement sometimes disappears spontaneously after matrimony.

FIG. 423.



Simple hypertrophy of breasts. (BRYANT.)

Supernumerary Nipples or Mammæ are occasionally met with, usually in the neighborhood of the normal organs, but sometimes in remote portions of the body. This malformation is, according to Bruce, most common in the male sex, the proportion of men affected, among those examined, being more than 9 per cent., and of women less than 5 per cent.; if from its situation the superfluous organ cause annoyance, *excision* may be resorted to.

Galactocele or Milk-Tumor consists in an accumulation of milk, in either a fluid or concrete condition, due to obstruction of one or more of the lactiferous ducts, from inflammation, or from the presence of a calcareous nodule —the latter constituting what is called a lacteal or mammary calculus. The quantity of milk which is found in these lacteal tumors is sometimes enormous. Birkett quotes from Scarpa the case of a woman aged twenty, in whom, two months after delivery, the breast was thirty-four inches in circumference, and rested on the thigh. The introduction of a trocar and canula allowed the evacuation of ten pints of fluid, which, by chemical examination, was shown to be normal human milk. Le Gros Clark has recorded a remarkable case in which two pints of milk were found in a large cystic adenocele.

The *treatment* in these cases consists in making an opening into the tumor, this being probably best done, as advised by Cooper, by introducing a trocar and canula, obliquely from the nipple towards the seat of accumulation, so as to leave a fistulous passage for the discharge of the milk. The child should, at the same time, be weaned (if the woman is suckling), and an attempt should be made to arrest the secretion by the local use of belladonna, the internal administration of iodide of potassium, etc. In those cases in which the accumulated milk is *coagulated*, an effort should be made to promote absorption by gentle friction and kneading with warm olive oil, or some other unirritating substance. Should these means fail, the tumor must be incised, when suppuration and subsequent healing will follow. The operation should not, however, be performed during pregnancy, lest abortion follow, an event which did occur, and with a fatal result, in one of the cases collected by Birkett. The treatment of *lacteal calculus*, which appears to be the result of calcareous degeneration in the seat of old inflammation, consists in excision.

Fissures and Excoriations of the Nipple and Areola constitute the affection commonly known as *Sore or Cracked Nipple*, and are particularly apt to be met with in the early periods of lactation, and after first labors. Beside interfering with the process of suckling, on account of the intense pain produced by putting the child to the breast, these cracks or fissures are apt, if neglected, to lead to acute inflammation of the nipple, if not of the mammary gland itself. This affection is sometimes traceable to contact of the delicate skin of the part with aphthous ulcerations in the child's mouth. The fissures, if deep, sometimes bleed, and the blood, being swallowed by the child while nursing, may be subsequently vomited. I have known a child only a few weeks old to be dosed with styptics, by direction of the practitioner in attendance, in order to check supposed hæmatemesis, until an inspection of the wet-nurse's breast, by another physician called in consultation, revealed the source of the vomited blood in a fissured state of the nipple.

The *treatment* of cracked nipple consists in the employment of frequent ablutions, and in the use of astringent washes, such as those containing borax, alum, tannin, or catechu, with emollient ointments, such as that of oxide of zinc. The application of nitrate of silver, in substance or solution, to the bottom of the crack, is an efficient but very painful remedy. Collodion, or the styptic colloid of Prof. Richardson, is useful in protecting the part from irritation. A large number of salves and ointments of different kinds are in popular use in the treatment of excoriated nipples, but are, with few exceptions, more often injurious than otherwise. The compound resin cerate of the U. S. Pharmacopœia has, under the name of Deshler's salve, acquired in this community a high reputation as a remedy for sore nipples. Fleischman speaks very favorably of a preparation containing lactate of zinc with glycerine and starch, while Charrier highly commends a solution of picric acid. E. T. Blackwell advises equal parts of glycerine and calomel. Whatever substance be employed, it should, for obvious reasons, be carefully washed off before applying the child to the breast.

Nipple-shields of lead or other metal, or of India rubber, are recommended by some authors as a means of protecting the part during the act of suckling. I should add that Le Diberder advises the administration of quinia in large doses, and considers local treatment of secondary importance.

Abscess of the Areola is to be treated by the application of emollient poultices, and by the early evacuation of the contained pus. The incision made for this purpose should be in a line radiating from the nipple towards the circumference of the breast, so as to avoid wounding any of the milk-vessels—an accident, the occurrence of which might lead to the formation of a troublesome fistula, or to permanent occlusion of the duct.

Condition of the Areola preceding Mammary Cancer.—Paget has recently described a granular state of the nipple and areola, in which the part resembles the glans penis when attacked by balanitis, and which he has observed in fifteen cases, in each of which cancer attacked the neighboring mammary gland within two years. Similar cases have been since recorded by Lawson, H. Morris, Manby, and other surgeons. Should such a condition be recognized, early excision would be indicated as a prophylactic measure.

Mammitis (*Mastitis, Mazoitis, Inflammation of the Breast, Mammary Abscess, Gathered Breast*).—Inflammation of the breast may occur during any stage of lactation, more rarely during pregnancy, or even at other periods. It is, perhaps, most common a few days after delivery—when it occurs as an exaggeration of the natural *raptus*, or determination towards the mammary glands, which accompanies the establishment of the flow of milk—and again towards the end of lactation, when, the functional activity of the glands being exhausted, these organs appear to resent the effort to force a continuance of the secretory act. The occurrence of this affection is often traceable to exposure to cold, to injury (as from sleeping with the distended breast compressed between the arm and body), to overdistension, from a neglect to suckle the child at proper intervals, or to the irritation produced by a cracked nipple.

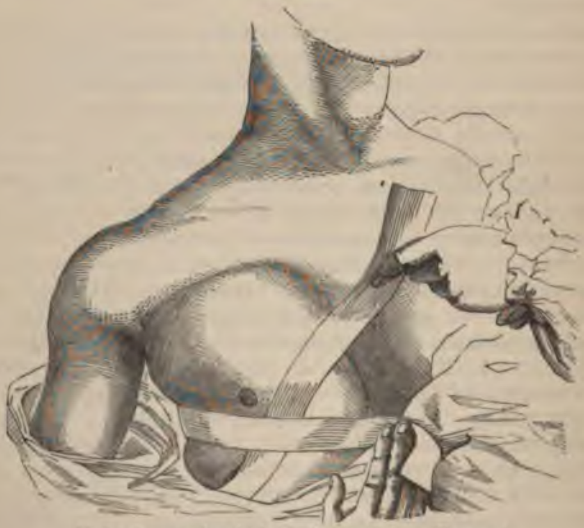
The *symptoms* of mammitis vary somewhat according to the seat of the inflammation, whether in the supra-mammary or submammary areolar tissue, or in the structure of the gland itself. In *supra-mammary inflammation*, the symptoms are those of ordinary phlegmonous inflammation in any situation; the affection is usually circumscribed, the resulting abscess rarely (according to Birkett) exceeding one or two inches in diameter. The skin over the seat of inflammation is, in these cases, red from the very beginning of the affection, the redness often preceding the other signs of the disease. The symptoms of *submammary inflammation* are more obscure; the form of the swelling is, however, characteristic in these cases, the whole breast being thrust forwards, and assuming a conical appearance. This is a more serious affection than that last described, suppuration following more constantly, and the abscess sometimes discharging itself by numerous openings around the circumference of the gland. In *inflammation of the mammary gland itself*, one or several lobes may be involved, the swelling in the latter case sometimes presenting a distinctly lobulated appearance. The skin over the inflamed part becomes œdematous, and, when suppuration is impending, assumes a dusky-red and polished appearance.

Treatment.—The constitutional treatment of inflammation of the breast consists in the administration of mild laxatives and anodyne diaphoretics, during the early stages of the affection, when there is often much fever and general sympathetic disturbance, followed by tonics, when suppuration has occurred. The patient's diet should be nutritious and abundant throughout the whole course of the affection, and malt liquors, or even more powerful stimulants, are often required in the later stages of the disease. An almost infinite variety of topical remedies has been recommended, and every nurse and neighbor of the patient is usually provided with at least one infallible cure; these volunteered prescriptions are, however, more often adapted to aggravate than to alleviate the patient's condition. Leeches are advised by many authors, but, beside debilitating the patient by the abstraction of blood, often seem to hasten, rather than to prevent, suppuration; if employed at all, they should be applied, as advised by Dewees, below rather than immediately over the affected surface. Rest of the inflamed organ is of the highest importance; to secure this, the breast should be supported in a sling, or in an elastic suspensory bandage (such as is in this city made for the purpose), and the arm should be kept to the side, so as to prevent motion of the pectoral muscle. The application of cataplasms, or of warm, emollient fomentations, is commonly both more soothing to the patient and more efficient than the use of evaporating lotions. Gentle and methodical friction with warm olive oil and laudanum, when it can be borne, is a valuable adjuvant to the other remedies employed. Belladonna plasters are used by many surgeons, and are supposed to arrest the flow of milk; they have, in my own experience, rarely been of much service. Dr. Dugas, of Georgia, recommends methodical pressure with a bandage.

As long as there is a prospect of obtaining resolution, the breast should be kept constantly exhausted, either by suckling, or, if this give too much pain, by the use of a breast-pump. When suppuration has occurred, the child should, I think, as a rule, be weaned; few women can, without injury, sustain the drain of a mammary abscess superadded to that of lactation, while the milk furnished under these circumstances is necessarily unsuited for a child's nutriment.

When an abscess has formed, the use of poultices should be continued, and as soon as decided fluctuation is manifested, a free incision should be made, in a line radiating from the nipple to the periphery of the breast. In most instances, the exact spot at which the opening should be made will be indicated by the occurrence of pointing, but should this indication not be present —as will often be the case if the abscess originate in the submammary region

FIG. 424.



Mode of supporting the breast by strapping. (DRUITT.)

—the incision should be made where fluctuation is most distinct, and, if possible, preferably I think at the *upper* part of the breast; this advice is contrary to that usually given, an opening in the most depending situation being commonly recommended; but the advantage of the superior incision is that, in the after-dressings, it allows the walls of the abscess to be more closely brought together by strapping.

As prolonged suppuration is undesirable, poulticing should be discontinued a few days after the opening of the abscess, and a piece of oiled lint, or a little simple cerate, laid over the wound. The breast should then be carefully strapped (Fig. 424), strips of adhesive plaster being applied in an imbricated manner, so as to firmly support and gently compress the whole organ. In some instances, particularly if the case have been neglected in its early stages, several openings form, which may persist and degenerate into troublesome sinuses; these may usually be induced to heal by careful strapping, and by the use of stimulating or astringent injections—tonics and concentrated food being at the same time freely administered—and if these means fail, the establishment of a seton (as recommended by Dr. Physick) should be tried, before resorting to the extreme measure of laying open the sinuses with the knife.

Chronic or Cold Abscess of the Breast is to be treated by making an opening in a convenient situation, and, if necessary, introducing a drainage tube, the breast being supported by strapping, while the general condition of the patient is improved by the administration of tonics and nutritious food. The arm should be kept to the side and supported in a sling.

Encysted Abscess is chiefly interesting on account of its having been frequently mistaken for solid tumor, and excision of the breast having, as a consequence, been unnecessarily performed. The diagnosis may be made by observing that abscess almost invariably originates during the pregnant or puerperal state, is not distinctly circumscribed, nor freely movable, is accompanied with subcutaneous œdema, and is commonly elastic, if not positively fluctuating. The exploring needle may be used in any case of doubt, and should always be employed before resorting to excision. The *treatment* of encysted abscess consists in the evacuation of the contained pus, and the subsequent formation of a seton or the use of stimulating injections, to promote the healing of the cavity. External support should at the same time be afforded by strapping. The induration in these cases may persist for a very long period.

Neuralgia of the Breast.—This is a distressing affection which may occur in connection with small glandular or other mammary tumors, or may exist independently of any discoverable local lesion. It is, according to Erichsen, commonly associated with uterine derangement. The *treatment* is that of neuralgia in general; tonics, such as iron and the valerianate of zinc, are usually indicated, and, as topical remedies, plasters of belladonna or opium will often be found serviceable. If the neuralgic condition be dependent upon uterine irritation, this must of course receive due attention.

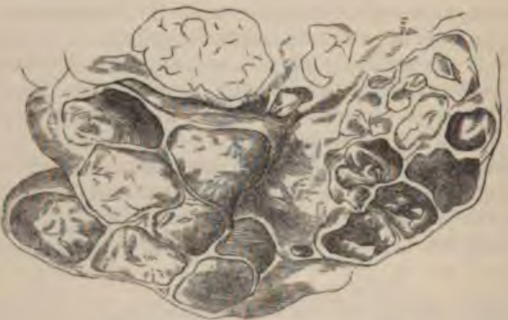
TUMORS OF THE BREAST.

The female breast is very frequently the seat of tumors, the chief forms of morbid growth of a *non-malignant* character met with in this situation being the cystic (simple or proliferous) and the glandular, though fibrous, sarcomatous, cartilaginous, and osseous tumors are likewise occasionally found in the breast, as are also true hydatids, scrofulous and tuberculous deposits, etc. Of the *malignant* growths, scirrhus is by far the most frequent, encephaloid coming next, and colloid and melanoid cancer being comparatively rare.

Cystic Tumors of the Breast. 1. *Simple Cysts.*—These are commonly single or unilocular, although multiple or multilocular cysts are also found in the breast. The most common variety is the *serous cyst*, but *oily cysts* are also sometimes met with in the mammary region. The pathology and general characters of these growths have already been considered (pp. 474, 475), and it merely remains to be stated that they commonly occur in young and otherwise healthy persons, increase very slowly in size, are rarely painful (except perhaps at the period of the menses), have a globular appearance, and an elastic or even fluctuating feel, are movable, occupy usually a limited portion of the breast, do not implicate the neighboring lymphatic glands, and are rarely attended with retraction of the nipple, or discoloration of the superjacent skin. If, however, a unilocular cyst be very large, and the skin over it thin and tense, the hue of the contained fluid may be apparent through the integument, or the tumor itself may be translucent, the affection being then sometimes designated as *Hydrocele of the Breast.* If, as sometimes happens, the cyst communicate with a milk duct, pressure may cause a small quantity of fluid to exude from the nipple.

Diagnosis.—The diagnosis of simple mammary cysts, if superficial, is attended with little or no difficulty, but if deep-seated these growths may be readily mistaken for cancer. Hence, in any case of doubt, the surgeon should not neglect the use of the exploring needle.

FIG. 425.



Brodie's sero-cystic sarcoma. (DRUITT.)

Treatment.—If the cyst be *single* or *unilocular*, a cure may sometimes be effected by the application of stimulating embrocations, such as the tincture of camphor with lead-water, or the tincture of iodine. Should these means fail, the cyst may be punctured and a seton established, or stimulating injections, with pressure, may be employed, so as to induce adhesion of the cyst walls; or a free incision may be made, and the cavity stuffed with lint, so as to convert the cyst into an abscess. Finally, if the cyst wall be thick, the whole tumor may be dissected out, the mammary gland itself being allowed to remain. In cases of *multiple* or of *multilocular* cysts, excision is the only mode of treatment to be recommended; and it may even be proper, in some instances, to remove the whole gland, so as to insure thorough extirpation.

2. *Proliferous Cysts with Vascular Intra-cystic Growths.*—The breast is the favorite seat of this variety of cyst, which constitutes the *Sero-cystic Sarcoma*

of Sir Benjamin C. Brodie (Fig. 425). Its pathology, mode of growth, and symptoms, and the means by which it may be diagnosticated from a cancerous growth, have already been sufficiently referred to (page 476). The only treatment likely to result in a permanent cure is complete excision of the affected breast.

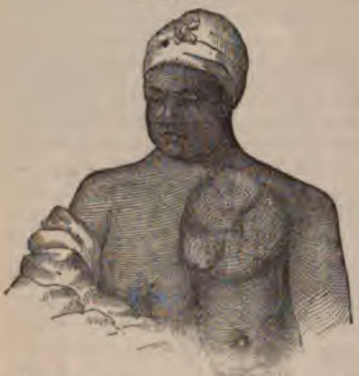
Glandular Tumor of the Breast (*Adenoid Tumor, Adenocele, Chronic Mammary Tumor*).—This affection appears sometimes to originate as a proliferous cyst, the intra-cystic growth gradually encroaching upon and filling the cavity of the cyst, which is thus converted into a solid tumor. The glandular tumor usually occurs in young women, and often accompanies irritation or other derangement of the reproductive organs. It is usually of slow growth (occasionally, however, increasing very rapidly), commonly painless, except, perhaps, at the menstrual periods, movable, circumscribed, and with a curved outline; it is somewhat nodulated, and does not implicate the neighboring lymphatic glands. Though often apparently isolated and unattached, this form of tumor is, according to Birkett, invariably connected with the tissue of the mammary gland—sometimes by a narrow peduncle—and is inclosed within the fascia of that organ. A section of the growth presents a somewhat granular appearance, and is at first of a bluish-white color, becoming, by exposure to the air, pinkish, and finally quite red. A viscid, glairy, synovia-like fluid may be sometimes expressed from the cut surface of the tumor, but is very different in character from the "cancer-juice" of scirrhus. By microscopic examination, the chronic mammary tumor is found to consist of gland-structure in various stages of development, surrounded by an investment of areolar tissue which divides the growth into minute lobules (see Fig. 214); the cæcal terminations of the gland-tubes contain epithelial scales. According to Ranvier, Virchow, and other modern pathologists, these growths are really fibrous, sarcomatous, or myxomatous tumors, in which the presence of hypertrophied gland structure is a mere secondary phenomenon. These tumors frequently contain cysts, and sometimes attain to a very large size; as in a case reported by Le Gros Clark, in which an adenocele weighing in all eleven pounds contained in a cyst no less than two pints of milk.

Treatment.—These growths sometimes cause little or no inconvenience, and remain without change for many years; this circumstance, together with the fact that their removal has sometimes been followed by a development of cancer *in sitû*, should make the surgeon hesitate to recommend excision in any case in which the tumor is indolent and not increasing. Under such circumstances, the treatment should consist simply in the adoption of measures to improve the general health, with the application of sorbefacients and compression. Should, however, the tumor assume a rapid growth, or should its presence be the source of anxiety to the patient, excision may be practised, and usually with excellent results. In such a case, it will commonly be sufficient to remove the tumor itself, with that lobe of the gland to which it is attached.

Painful Mammary Tumor (*Irritable Tumor of the Breast*).—Two varieties of tumor are embraced under this name, one of an adenoid or glandular character, and the other a true "painful subcutaneous tubercle" (see page 489). The *treatment* consists in the administration of tonics, with compression, and the local use of anodynes—or in excision, which may be confidently expected to give permanent relief.

Sarcomata of the Breast are chiefly of the round-celled or spindle-celled (fibro-plastic) variety, though myeloid (giant-celled) growths are also occasionally met with in this locality. Mammary sarcomata often contain cysts, and are sometimes indistinguishable from encephaloid growths without microscopic examination. The *treatment* consists in excision, but the growth is apt to recur.

FIG. 426.



Mammary sarcoma with large cysts; the tumor weighed over six pounds. (From a patient in the Episcopal Hospital.)

Cancer of the Breast.—The breast[1] is the favorite seat of *Scirrhus*, which is also the most frequent form in which cancer occurs in this locality. *Atrophic Scirrhus* is a term used by Collis, and some other writers, for those forms of scirrhous cancer which reduce the organ in which they are seated below the normal size, while the term *Lardaceous Scirrhus* is used to designate those tumors in which, along with the cancer cells, there is also a deposit of a large quantity of fat—the name aptly indicating the brawny feel and appearance (like that of a hog's skin) which is observed in cases. The *lardaceous* cancer must not be confounded with the cancer "*en cuirasse*" (p. 498), which commonly runs a course as chronic as that of the other is acute.

Encephaloid of the breast is a much rarer affection than scirrhus, the proportionate number of cases being variously estimated, by different writers, as from one-twentieth to one-fifth. In some cases, the tumor appears, microscopically, to occupy an intermediate position between scirrhus and encephaloid, and to such growths the terms *Acute Scirrhus* and *Firm Medullary Cancer* have been applied. *Melanoid* and *Colloid Cancer* are also occasionally, but very rarely, found in the breast. Many cases which would formerly have been considered examples of encephaloid cancer of the breast, are classed by modern pathologists as cases of round-celled or spindle-celled sarcoma. They are clinically quite as malignant as true cancers.

Diagnosis.—The structure and microscopic appearance of these various forms of cancer as well as their course and symptoms, have already been sufficiently described in Chapter XXVI., and I shall, therefore, in this place merely recapitulate those points which may serve to aid in the diagnosis between *scirrhus* and *non-malignant* solid mammary tumors; *encephaloid* is not likely to be confounded with any other tumor, except certain varieties of sarcoma which, clinically, are equally malignant.

Non-malignant Tumors are somewhat nodulated, not very hard, occasionally partially elastic, movable, and non-adherent.	*Scirrhus*, on the other hand, originating as a small nodule, is from the first of a stony hardness, and soon becomes fixed and adherent to subjacent tissues, being evidently *infiltrated*[2] among the structures in which it is developed.
They are covered with healthy skin, except in the ulcerative stages of the sarcomata, and the skin even then does not appear infiltrated, as in the case of scirrhus.	The skin becomes widely involved, having a peculiar pitted or dimpled appearance, from the shortening of various subcutaneous fibres. In an extreme degree, this pitting gives the whole breast a brawny or lardaceous appearance.

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[1] According to Török and Wittleshöfer, the right breast is somewhat oftener affected than the left.

[2] A remarkable case of capsulated scirrhus has, however, been recently recorded by Cullingworth, of Manchester.

The nipple is rarely retracted, and the superficial veins are not markedly dilated. There is seldom much pain, except in the case of the "irritable tumor," and then continuous, and of a neuralgic character.	The nipple is commonly retracted, and the superficial veins dilated. The pain is severe, but not continuous, of a lancinating or "electric" character.
The neighboring lymphatic glands are not involved; there is no tendency to multiplication in internal organs, and, therefore, no cachexia; and the tumor, which grows slowly, rarely recurs if it have been thoroughly excised. (Sarcomata, however, grow rapidly and are very apt to recur.)	The neighboring lymphatic glands, particularly those in the axilla and above the clavicle, become involved in the disease, which is often attended by a marked state of cachexia. The tumor usually grows pretty rapidly, is attended with ulceration often of a peculiar character (p. 484), and frequently recurs after apparently thorough removal.
Non-malignant mammary tumors may occur at any age, but are most common in women less than forty years old.	Scirrhus is seldom met with in persons under forty years of age.

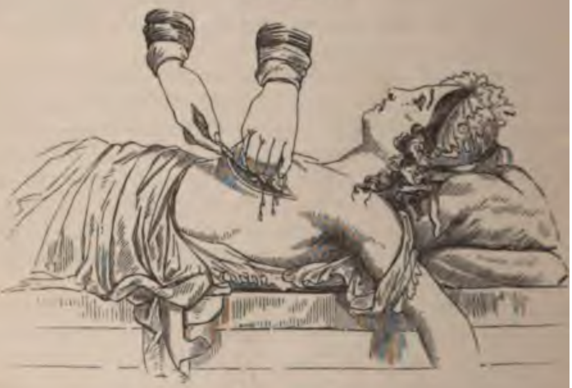
Prognosis.—The prognosis of cancer of the breast is, of course, unfavorable. The most rapidly fatal cases are those of *encephaloid*, and of *lardaceous scirrhus*, and the least so, those which assume the *atrophic* form. The latter are chiefly met with among old persons, and, the course of the disease being chronic, death may ensue from some other cause. In the *cuirass-like* form of the affection, again, life is often prolonged for a considerable period; in these cases the virulence of the disease appears to be expended mainly upon the skin, the lymphatic glands and internal organs not being implicated until at a comparatively late stage. Thickening and tenderness of the periosteum in the upper portion of the humerus of the side affected, has been observed by Snow, and is by him supposed to indicate implication of the medulla—of course an unfavorable symptom.

Treatment.—The only treatment which offers any prospect of permanent benefit, in cases of mammary cancer, is excision of the tumor, together with the whole mammary gland—though, as palliative measures, compression and the application of cold may occasionally be of service (see page 505). If the tumor, though in the region of the breast, do not appear to involve the mammary gland, it will usually be sufficient to remove that portion of this organ which is nearest the cancerous mass—unles the tumor be below or on the sternal side of the gland, when, as the latter becomes infiltrated at an early period, total excision should be practised.

Operative measures are not, however, to be indiscriminately resorted to in every instance. Certain cases are totally unsuited for excision:—such are those in which there are multiple tumors; in which there is extensive implication of the lymphatic glands, particularly of those above the clavicle; in which the disease appears to have involved internal organs; in which there is wide-spread ulceration; or in which the whole integument of the breast is brawny and lardaceous. The presence of any of these conditions would forbid the hope of being able to effect thorough extirpation, and would therefore render operative interference improper. Nor, again, would excision be, as a rule, advisable, in a case of atrophic or cuirass-like cancer, occurring in an old person, nor in any case in which, from the general condition of the patient, or from other circumstances, the operation would probably be in itself attended with unusual risk. Excluding all these cases, however, there remain a large number—probably a majority—in which early excision is highly desirable, and in which the surgeon should urge its performance. The reasons upon which this advice is grounded have already been given (page 505). Slight browniness of the integument, limited ulceration, moderate adhesion to subjacent structures, or even slight lymphatic implication, though unfavorable circumstances, do not necessarily contra-indicate the

clothing so arranged as fairly to expose the breast and upp
The arm is then held out of the way by an assistant, in such
to render tense the fibres of the pectoral muscle. If the tu
malignant and of moderate size, a single incision will suffice;
simple oblique cut in the direction of the muscular fibres; or,
be required, may be made in the form of a double curve, o
removal of malignant growths, however, the affected portion o
must itself be excised; and here two semilunar incisions may
one below and the other above the nipple, which is included b
or a double **S** incision (Fig. 235), or, if the tumor be very larg

FIG. 427.



Excision of the breast. (FERGUSSON.)

incision over its upper part, and two shorter longitudinal incisi
below the nipple, which is thus removed with a triangular p

When, by careful examination of both tumor and wound, the surgeon has satisfied himself that all the diseased structure has been removed, attention should be directed to the state of the axillary glands. It may happen that a single gland is enlarged, but not markedly indurated, and that it is so, apparently, as the result of transmitted irritation, rather than from being itself carcinomatous. Under such circumstances, the axilla should not be interfered with, the gland being watched, however, and, if necessary, subsequently removed by a separate operation. If the axillary glands are evidently involved in the disease, though not so extensively implicated as to forbid operative treatment altogether, it is usually advised that they should be removed, the upper extremity of the incision being extended as far as necessary for this purpose. This is the course which I have myself always pursued, and it is, as mentioned, in accordance with the teaching of most authors. It is but right to add, however, that the late Mr. Collis (for whose opinion I have the highest respect) deprecated incisions into the axilla in almost all cases, believing that such incisions were apt to be followed by the development of lardaceous cancer of the arm and side, and that they were likely to hasten the death of the patient. When axillary glands are to be removed, they should as far as possible be *enucleated* with the fingers and handle of the scalpel, rather than excised—the use of the edge or point of the knife being, in the deep portions of the axilla, attended with considerable risk. If the implicated glands should unfortunately be so deeply attached as not to admit of complete removal, the best that can be done is to draw down the mass and throw a strong ligature around its base, cutting off the part below the seat of strangulation, in hope that the remainder may be destroyed by sloughing.

The wound left by the operation of excision of the breast should be simply dressed. A few ligatures only are commonly required; the lips of the wound are brought together with a few points of suture, or with adhesive strips, a piece of oiled lint, covered with oiled silk, being then applied, and held in place with strips of plaster or a light bandage. The arm should be laid across the chest, so as to relax the parts, and thus facilitate union, but should not be closely confined. The mortality from the operation is small, in view of the extent of the wound, being, even in hospital practice, less than ten per cent. Of 147 cases of mammary cancer operated on by Syme, only 10 terminated fatally, while the result in 55 excisions of the breast for non-malignant tumors was uniformly successful. The chief risks are from the development of erysipelas or pyæmia. Dr. B. W. Richardson has excised the breast with *scissors*, the parts being previously rendered insensible by using the ether spray, and the same plan has been since successfully adopted by Mr. Thomas Moore.

Dr. T. G. Thomas has suggested an ingenious mode of removing non-malignant mammary tumors without the production of deformity. He makes a curved incision immediately *below* the breast, turns up the gland, and enucleates the morbid growth from beneath. The gland is then replaced, and the resulting cicatrix is entirely hidden from view.

The Mammary Gland in the Male may occasionally be the seat of disease; thus it has been found hypertrophied, and has been known to furnish a secretion of milk, while it is sometimes the seat of cystic or adenoid growths, or of cancer. Wagstaffe has collected 71 cases of the latter form of disease occurring in this situation. The *treatment* is the same as for similar affections in the female.

CHAPTER XL.

HERNIA.

THE term *Hernia* signifies a protrusion of any portion of the viscera through an *abnormal* opening in the walls of the cavity within which the protruded part is naturally contained. A protrusion through a *normal* aperture is not a hernia; thus the term is never applied to a protrusion of the bowel through the anus, or of the womb through the vulva. Herniæ of the brain and of the thoracic viscera have already been considered in previous portions of the volume; and the subject for discussion in this place is therefore limited to *Abdominal Hernia*, or, as it is familiarly called, *Rupture*.

Any part of the abdominal parietes may give passage to a hernia, but rupture is most likely to occur where the muscular and tendinous structures are comparatively weak, as where the spermatic cord or round ligament issues from the abdomen, where the femoral vessels pass into the thigh, or at the umbilicus.

CAUSES OF HERNIA.

The *Predisposing Causes* of rupture may be divided into such as pertain to the *general* condition of the patient, as age, sex, etc., and such as pertain to the *local* condition of the part in which the hernia subsequently occurs; the latter are called by Birkett the *Inciting Causes*. The *Immediate* or *Exciting Cause* of rupture, when any such can be alleged, is usually some violent exertion, as in lifting, coughing, or straining.

General Predisposing Causes. 1. *Age.*—The majority of cases of hernia are developed in infancy, or early adult life; more, that is, before the age of thirty-five years than afterwards. This statement is contrary to the ordinarily received doctrine, but has been clearly established by the researches of Mr. Kingdon (of the City of London Truss Society), Mr. Birkett, and Mr. Croft. As, however, the number of infants and young persons in every community is much larger than that of adults, the *relative* frequency of hernia is greater as old age approaches. Thus advancing age may be considered a predisposing cause of hernia.

2. *Sex.*—The male sex is unquestionably more predisposed to the occurrence of hernia than the female, the proportion for all ages and forms of the disease being, according to Croft, about three to one. The difference is most marked in infancy and early childhood, on account of the frequency of a congenital malformation in the male, which will be presently referred to.

3. *Occupation.*—The majority of cases of hernia occur among the laboring classes, but there does not appear, according to Kingdon, to be any direct connection traceable between the development of rupture and the pursuit of any particular occupation.

4. *Inheritance.*—A predisposition to hernia is frequently inherited, the first year of life being that in which the hereditary influence is most marked. The anatomical peculiarities on which the frequent occurrence of hernia at this early age depends, are, (1) imperfect closure of the ventral orifice of

the vaginal process of the peritoneum, and persisting patulousness of that canal, and (2) abnormal lengthening of the mesentery. The first-named malformation is always, and the second often, probably, of congenital origin; they will be again referred to under the heading of inciting causes.

Local Predisposing or Inciting Causes. 1. *Wounds*, etc.—The occurrence of hernia is occasionally predisposed to by wounds or subcutaneous lacerations of the abdominal parietes. *Ventral* hernia usually results under these circumstances (see page 375), but if the wound be suitably situated, inguinal, or any other form of hernia may ensue.

2. *Weakening of the Abdominal Parietes*, as the result of previous inflammation, abscess, etc., or from over-distension by the pressure of the gravid uterus, by the accumulation of fat in the omentum or mesentery, or by the development of ovarian tumors, or of ascites, may act as a predisposing cause of hernia.

3. *A Patulous Condition of the Vaginal Process of the Peritoneum, or of its Ventral Orifice*, is a frequent predisposing cause of hernia. It is known that the testicles are, in the earlier periods of fœtal life, situated in the lumbar region, whence they gradually descend into the scrotum. During their descent, they are behind and partially invested by the peritoneum, a prolongation of which membrane accompanies them into the scrotum, where it forms the tunica vaginalis on either side. This *vaginal process of the peritoneum* at first forms one common sac with that of the peritoneum itself, and the communication between them often persists at birth, or even a month or two later. Usually, however, about the period of birth, the vaginal process divides into two portions, by the contraction of the sheath and the formation of adhesions between its sides, at about the position of the head of the epididymis. The lower portion invests the testicle (forming the *tunica vaginalis propria testis*), while the upper portion lies in front of the spermatic cord, and constitutes the *tunica vaginalis propria funiculi*. In the normal state, the tunica vaginalis of the testicle continues through life as a closed sac, while the tunica vaginalis of the cord becomes obliterated and converted into a delicate fibrous band. It not unfrequently happens, however, that the funicular portion of the vaginal process persists as a tube of small calibre, closed at both ends, or, more rarely, that either its ventral or testicular orifice, or both, remain patulous. The *testicular* orifice is, of course, that by which the funicular portion communicates in fœtal life with the testicular portion of the vaginal process of the peritoneum, while the *ventral* orifice is that by which it communicates with the general cavity of the peritoneum, and corresponds in position with the internal abdominal ring. From the above brief anatomical description, it can be readily understood that a patulous state of the vaginal process, or of its ventral orifice, would predispose the person in whom it existed to the occurrence of rupture.

4. *A Relaxed and Elongated Condition of the Mesentery* acts as a predisposing cause of hernia. That the mesentery is actually elongated, in many cases of hernia, can scarcely admit of a doubt—for the bowel could not descend as low as it is observed to do in the scrotum, were its mesenteric attachments not abnormally relaxed—but whether this relaxation and elongation be a *cause* or *consequence* of hernia, is a different question; that it is often a cause of rupture, is rendered probable, as pointed out by Birkett, by the facts that (1) persons with a hernial sac are more troubled by the descent of a hernia when out of health than at other times; (2) persons of a relaxed frame are more apt than others to become subjects of hernia, as they advance in life; and (3) in middle-aged persons of either sex, affected with hernia, the abdominal viscera generally are less firmly held in place

by their peritoneal attachments, than in those who have no disposition to hernia. This elongation of the mesentery may, as just mentioned, be due to a relaxed state of the fibrous tissues, acquired at any period of life, or may probably, in some cases at least, be of congenital origin.

5. *The Gradual Stretching and Protrusion of the Parietal Peritoneum* at weak parts of the abdominal wall, as the result of frequently repeated muscular exertion, of coughing, of straining at stool, or in urinating, etc., may act as a predisposing cause of hernia, by leading to the ultimate development of a sac or pouch into which the viscera may be received, this pouch then constituting the *sac of the hernia.*

6. The existence of *phimosis* appears in some cases to act as a predisposing cause of hernia by causing straining in micturition.

Immediate or Exciting Causes.—In the majority of instances, probably, a hernia is slowly developed, and may not attract the patient's attention until fully formed; in other cases, however, the rupture occurs suddenly, as the result of a fall, or of some violent muscular effort.

NOMENCLATURE.

Herniæ are classified according to their (1) *locality*, as inguinal, femoral, scrotal, umbilical, etc.; (2) *condition*, as reducible, irreducible, strangulated, etc.; (3) *contents*, as intestinal (enterocele), omental (epiplocele), vesical (cystocele), etc.; and (4) *period of development*, as congenital, infantile, etc. The latter mode of classification is, however, incorrect, as many cases of so-called congenital and infantile hernia do not occur until adult life.

STRUCTURE OF A HERNIA.

The hernia consists essentially of a *sac* and its *contents*, the tissues external to the sac being the skin, subcutaneous fascia, etc., of the part in which the hernia occurs. In some instances the sac is wholly or partially deficient, as in cæcal and vesical herniæ, certain congenital umbilical herniæ, and in ventral herniæ resulting from penetrating wounds. With these exceptions, every hernia has a sac (or peritoneal investment), that part which communicates with the peritoneal cavity being the *neck*, and that which surrounds the protruded viscera being the *body* of the sac.

Varieties of the Hernial Sac.—There are two distinct varieties of the hernial sac, the *congenital* and the *acquired.*

1. The *Congenital Sac* consists of the patulous vaginal process of peritoneum, or of its funicular portion, and is therefore only met with in those forms of oblique inguinal hernia which are often, though improperly, termed congenital and infantile. It may exist through life as a pouch, communicating with the peritoneal cavity, without ever becoming the seat of an actual hernia.

2. The *Acquired Sac* is slowly developed by the gradual stretching of a portion of the parietal peritoneum, as the result of frequently repeated pressure from within, exercised by the organs which ultimately form the contents of the hernia. This is the form of sac which exists in the ordinary oblique and direct inguinal herniæ, as well as in femoral hernia, and in those which occur in other regions.

The *mode of development* of the acquired hernial sac has been particularly studied by Cloquet and Demeaux, and is well described by Birkett. When the parietal peritoneum first protrudes through the abdominal wall, the widest portion of the sac is that which communicates with the peritoneal cavity, but in the fully formed sac, the neck is smaller than the body, the sac being puckered like the mouth of a purse, by the constriction of the fibrous or muscular ring through which the hernia has escaped. In this stage of the hernial sac's development, which is called the *period of formation*, the neck of the sac itself exercises no constriction upon the protruded viscus, and the puckering which has been described disappears upon reduction of the hernia, or upon division of the ring of the abdominal wall through which the rupture has occurred. At a later stage, the *period of organization*, the puckered folds at the neck of the sac adhere together, while at the same time the fat disappears from the adjacent subserous areolar tissue, this becoming converted into an indurated and vascular ring which is said to contain a layer of contractile fibres. In this stage, the neck of the sac exercises an essential constricting power, and requires to be divided if the hernia becomes strangulated. The ultimate stage is the *period of contraction;* as soon as a hernia ceases to descend, the orifice of the sac manifests a disposition to contract, aad may even become obliterated, thus accomplishing the cure of the disease—as is occasionally witnessed in the herniæ of infants, and more rarely in those of adults. During this stage, the ring which surrounds the neck of the sac becomes thicker, and of a fibrous or cartilaginous hardness. If the hernia protrude in this stage, strangulation is very apt to occur.

The sac of a hernia is thus at first thin and translucent, but often at a later period becomes thick and indurated, and may even become the seat of calcareous degeneration; in other instances, as in cases of large umbilical hernia, the sac may by distension become extremely attenuated.

The aperture in the abdominal wall through which a hernia has escaped eventually assumes a more or less circular outline, and often becomes enlarged; it may become displaced by the weight of the protruding viscera, being usually dragged downwards and towards the median line of the body; thus, in an oblique inguinal hernia of long standing, the internal may come to be placed directly behind the external abdominal ring. The superficial tissues frequently become thinned and stretched, but, if a truss have been employed for a long time, may be indurated and thickened from the pressure of the pad of the instrument.

Contents of the Hernial Sac.—Almost any of the viscera may be occasionally found in herniæ, but the parts most usually protruded are the *bowel* and *omentum*. The small intestine, and particularly the ileum, is much more frequently involved in a hernia than the large intestine: only a portion of the calibre of the gut may enter the sac, or a large coil of bowel with its mesenteric attachment. In some very large herniæ, almost the whole of the small intestine may descend into the sac. When long protruded, the bowel becomes thickened and contracted, and of a grayish hue externally; its mesentery at the same time becomes hypertrophied and vascular. When the sac of a hernia is habitually occupied by omentum, the latter tissue becomes indurated and thickened, and often matted together into a conical mass, the apex of which corresponds to the neck of the sac. The omental veins become distended and varicose, and apertures or depressions often exist in the dense mass, into which a knuckle of intestine may slip, and become strangulated, When a hernial sac contains both bowel and omentum, the latter usually protrudes in front of, and may completely surround, the gut. *Cysts* sometimes exist in the protruded omentum, and may, in the operation of herniotomy, confuse the surgeon by their resemblance to knuckles of intestine. In addition to the viscera which are contained in the hernial sac, a certain amount of *serous fluid* always exists in its interior:

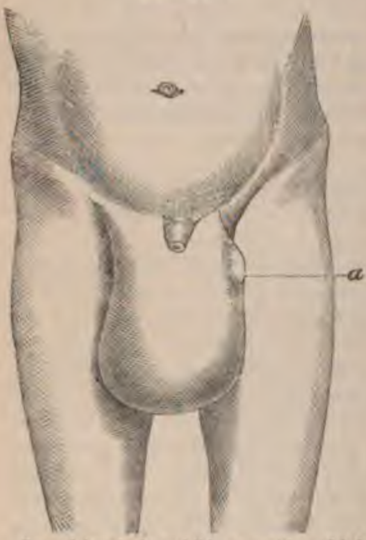
under ordinary circumstances the quantity is but small, but if the hernia become inflamed or strangulated, may be very much increased. *Adhesions* often exist in the sac of an old hernia, gluing together the contained viscera, or binding them to the wall of the sac itself; while recent, these adhesions are soft and easily separated, but in cases of long standing they become firm and form an impediment to reduction. *Loose bodies*, consisting apparently of detached appendices epiploicæ, are occasionally found in the interior of a hernial sac.

Hydrocele or Dropsy of a Hernial Sac is the name given to an unusual condition which consists in the accumulation of fluid in the bottom of a hernial sac, the communication of which with the abdominal cavity is occluded, either by obliteration of the orifice, or by the formation of adhesions between the wall of the sac and the viscera which occupy its upper portion. Cases of this form of disease, which, rare in any situation, is particularly so in connection with femoral rupture, have been recorded by Pott, Pelletan, Boyer, Lawrence, Curling, Erichsen, Langton, and W. F. Atlee, of this city. The *treatment* consists in evacuating the fluid by means of a trocar and canula, and, as advised by Langdon, if the effusion recurs, in the establishment of a seton.

SYMPTOMS OF HERNIA IN GENERAL.

The patient often experiences a sensation of weakness in the groin or other region in which a hernia is about to occur, before any protrusion takes place. There is also frequently a decided fulness in the part, which is most marked in the erect posture, or upon contracting the abdominal muscles. The hernia, if gradually developed, appears as a small tumor, not larger, at first, perhaps than the tip of the finger, which can be reduced by pressure, and which disappears spontaneously when the recumbent posture is assumed. In young children, the hernia is often of considerable size when first noticed, and the same is true of those cases of rupture which are suddenly developed as the result of violent exertion; in the latter cases, the formation of the hernia is often attended with pain. A fully developed hernia forms a round or oval tumor, usually broader below than above (the *neck* of the hernia), increasing in size when the patient stands up, holds his breath, or coughs, either subsiding spontaneously when the patient lies down, or being readily reduced within the abdomen by gentle pressure, and reappearing upon the resumption of the erect posture. When the patient coughs, a distinct *impulse* may be commonly perceived in the hernial tumor. The symptoms of hernia are somewhat modified by the nature of the contents.

FIG. 428.



Scrotal hernia in a child; *a*, position of left testis. (From a patient of Dr. C. B. Nancrede.)

Intestinal Hernia or Enterocele.—When the hernia contains bowel only, the tumor is smooth, gurgles under pressure, and is often tympanitic and resonant when percussed. The hernia is often the seat of *borborygmus* or flatulent rumbling. The impulse on coughing is well marked, and the patient frequently complains of dyspeptic symptoms, and of an uncomfortable dragging feeling. Reduction is attended with gurgling, and with a peculiar, characteristic sensation, which, when once felt, can scarcely be mistaken, and which is spoken of by some writers as the "slip" or "flop" of a hernia.

Omental Hernia or Epiplocele.—In these cases the tumor is irregular and comparatively ill-defined, having a doughy feel, and with a less distinct impulse on coughing than in the form of the disease last described; reduction is effected gradually, and without the characteristic gurgling sensation which has been referred to. Omental hernia is said to be most frequent on the left side, and is chiefly seen in adults.

Mixed Hernia or Entero-Epiplocele.—In these cases the symptoms of the intestinal and omental hernia are variously combined.

Cæcal Hernia is of course confined to the right side, and is commonly irreducible, from that portion of cæcum which is uncovered by peritoneum forming adhesions to the subjacent structures.

Herniæ of the Stomach or Bladder are of rare occurrence; the former (*Gastrocele*) has been observed in the inguinal and umbilical regions, and in cases of diaphragmatic rupture; there are no distinctive symptoms by which it can be certainly recognized during life. Hernia of the bladder (*Cystocele*) is irreducible, and attended with difficult micturition; urine may be made to flow by compressing the tumor.

Hernia of the Ovary is occasionally met with, Hamilton having collected 13 cases, to which Balleray has added 5 others.

TREATMENT OF REDUCIBLE HERNIA.

The treatment of reducible hernia may be *palliative*, or may aim at effecting a *radical cure*.

Palliative Treatment.—This consists in preventing the descent of the hernia by the application of a suitable *truss* or *bandage*. In cases of umbilical and ventral rupture, an elastic band and pad may be the best means of retention, but a truss is preferable for the ordinary forms of hernia. I do not purpose to enter into any discussion of the comparative merits of the many forms of truss which are offered by their respective inventors to the profession and the public, but shall merely mention what may be considered the requisites of a good truss.

A *Truss* consists essentially of a *pad* and a *spring;* the *pad* should be firm, slightly convex upon the surface (except in particular cases), of an oval or elongated triangular shape, and sufficiently large to compress not only the aperture through which the hernia escapes, but the whole canal through which it has passed to reach the surface. The pad may be of buckskin, firmly stuffed, of polished wood, or of such other material as may be found by experience to produce least irritation of the skin, some patients in this respect differing from others. In certain cases, in which the ring through which the hernia protrudes is very large, the ordinary convex, oval, or triangular pad may be advantageously replaced by one of a horseshoe or ring shape, as recommended by Mr. J. Wood, or by a pad containing a spiral spring, as suggested by Mr. Holthouse. As a rule, the plate which forms the back of the pad should be made of the same piece of metal as the spring, while the bearing of the pad should be not directly inwards, but somewhat upwards as well, the particular angle varying according to the shape of the patient's abdomen. The *spring* of a truss is made of metal (covered with buckskin or leather), and curved so as to pass around the patient's trunk, just above the rim of the pelvis; it should not touch except at the point of counterpressure, which, in the ordinary single-pad truss, is at the patient's hip, on the opposite side to that of the rupture—and at this point the spring should be beaten thin, curved to fit the part, and suitably padded. The spring should be elastic, and should exercise just enough force to keep the hernia reduced, without pressing so deeply as to cause absorption of the abdominal parietes. From the free end of the spring, a leather strap passes to the pad, thus completing the circle around the patient's pelvis, while, for additional security, another strap may pass from the body of the spring along the fold of the buttock and around the inside of the thigh, to be fastened to a button at the lower edge of the pad.

In many cases, particularly in those of persons with fat and pendulous abdomens, it is difficult to keep a hernia reduced except by using a spring of such force as to produce great discomfort, besides incurring the risk of encouraging the development of a rupture on the opposite side; under such circumstances, it will be better to employ a double-pad truss, thus affording support to both sides of the abdomen. The points of counterpressure, when such an instrument is used, are situated on either side of the spine. The double-pad truss is, of course, necessary in cases of *double hernia.*

Before applying a truss, the hernia should be completely reduced, and the apparatus then adjusted while the patient is in the recumbent posture; the truss may be left off at night, being removed after the patient is in bed and re-applied before he rises, but should be constantly worn at other times. Every one who is ruptured should be provided with at least two trusses, so that if one break, another may be immediately substituted; and it is well to have one furnished with a plain wooden pad, for use while bathing, etc. If the pad of a truss tend to produce chafing, as is apt to be the case in hot weather, the part should be frequently washed with alum and whiskey, or cologne water, and well dusted with ordinary toilet powder, or lycopodium. The necessity of constantly wearing the truss, and of never permitting the descent of the hernia, cannot be too strongly insisted upon. The only circumstance which should be allowed to prevent the use of the instrument, is the presence of an undescended testis in such a part of the inguinal canal as to render the pressure of the truss-pad unbearable; and even such a case should not be abandoned without an attempt to effect the desired object by trying various forms of apparatus.

As a test for the efficiency of a truss, Erichsen advises that the patient should be directed to cough, while sitting on the edge of a chair, leaning forwards, and with the legs extended and widely separated; if the hernia do not slip down behind the pad under these circumstances, the instrument may be considered satisfactory.

Radical Cure of Hernia.—In those cases in which the vaginal process of the peritoneum constitutes the sac of a hernia (*congenital sac*), the application of a well-fitting truss will occasionally effect a cure (particularly if the patient be an infant), by inducing the formation of adhesions between the opposing sides of the canal, and thus imitating the process of nature in accomplishing the closure of the part. In the other forms of hernia, in which the sac is slowly developed (*acquired sac*), it may be possible to *prevent* the formation of the sac by the employment of a truss; but when once formed, all that can usually be hoped for, in the use of the instrument, is to check the further enlargement of the sac by keeping the hernia constantly reduced, though Dr. C. T. Hunter has recorded a case in which, by the patient's constantly pressing the testicle of the affected side against the inguinal ring, the gland eventually became fixed in that situation, and thus effected a cure.

Castration, excision of the sac, ligation or scarification of its neck, and acupuncturation, have at various times been recommended and practised, in the hope of producing a radical cure of hernia, but are now matters chiefly of historical interest, though excision (with antiseptic precautions) has been recently revived by Pauly and Czerny. The injection of the sac with the tincture of iodine has been advantageously resorted to by J. Pancoast, as has the injection, outside of the sac, of an extract of white oak bark by G. Heaton and J. H. Warren, of Boston. Gerdy's operation, which consisted in simply invaginating a portion of the sac and superjacent integuments, by pushing them up with the finger into the canal through which the rupture descended, and holding them up with sutures, while adhesion was promoted by the application of liq. ammoniæ to remove the cuticle of the invaginated part, has been revived with various modifications and improvements by Syme, Fayrer, Wutzer, Wells, Davies, Armsby, Egea, Langenbeck, Agnew, and others; while J. Wood has devised another very ingenious procedure, combining invagination with ligation of the neck of the sac. Invagination of the testicle with the sac is, according to Michel, an old Spanish mode of treatment. The subcutaneous employment of the silver-wire suture has been recently recommended by Richardson, of New Orleans, and by Chisolm, of Baltimore. The more important operations for the radical cure of hernia will be described under the heads of the special forms of the disease for which they are adapted; but it will be convenient to refer, in this place, to the general question of the applicability of such modes of treatment.

The objections to any operation for the radical cure of hernia, are (1) the *risk* by which the procedure is necessarily attended, and (2) the probability of *failure* by the hernia recurring in spite of the operation.

(1.) There is, in the first place, the *risk* of inflicting direct injury upon important vessels, the peritoneal cavity, or even the bowel itself. A skilful operator could doubtless avoid these accidents, yet the possibility of their occurrence should be borne in mind in estimating the dangers of the procedure. But even if no such untoward event as has been referred to mars the progress of the operation, it is evident that in every case there is necessarily a risk of the development of peritonitis; for every operation aims to effect a cure by inducing a certain amount of inflammation in the neck of the sac, and it is impossible to be sure that this inflammation may not spread further than is intended. And, although the statistics of various modes of operating show that but few deaths have actually occurred from peritoneal inflammation, in proportion to the number of cases in which the operations have been performed, yet, as justly remarked by Birkett, these facts only show that peritonitis is not a necessary consequence of the procedure.

(2.) If, however, the chance of a fatal termination is small, the probability of *failure* is comparatively great. Mr. Wood has pointed out that the main cause of failure, in most operations for the radical cure of hernia, lies in the neglect to include the posterior wall of the canal in the part operated on, the rupture sooner or later redescending behind the seat of operation; and hence a prominent feature in his own mode of procedure, consists in drawing forward the posterior wall of the canal, so as to induce its adhesion to the anterior; yet of one hundred and eighty-eight cases referred to in his address to the British Medical Association, in 1873, three ended fatally, while fifty-one in all terminated in failure; of many more the termination was doubtful; and only fifty-six were known to have remained well a year or more after their discharge from hospital. Another cause of failure, which equally affects every form of operation, is strongly insisted upon by Birkett, though denied by Wood; this is the existence of relaxation and elongation of the mesentery, which will, when present, tend to allow the reproduction of the rupture in the same or another part.

Hence it would appear that the most favorable view to be taken of any operation which has been as yet proposed for the radical cure of hernia, is that while not necessarily followed by grave consequences, it is not unattended with risk, and by no means certain to effect the object designed; and that, in consideration of the safe and really satisfactory means of palliation afforded by the use of a truss, the radical treatment must be looked upon as at best an operation of complaisance or expediency. The most favorable cases for operation are probably those of hernia into the vaginal process or its funicular portion, the so-called congenital or infantile cases; for, as remarked by Birkett, it is almost exclusively in these cases that a natural tendency to spontaneous cure has been observed. The operation is doubtless justifiable in exceptional instances, as when it is found impossible to maintain reduction by means of a truss, or when the occupation of the patient or other causes render the inconvenience of wearing a truss more than ordinarily burdensome; but, though occasionally justifiable, the operation is not, in any case, one to be urged upon the patient, nor to be performed without his fully understanding the uncertainties and dangers of the procedure; and, in the immense majority of cases, the surgeon will best consult both his own reputation and the good of his patient by dissuading from any but palliative treatment.

Irreducible Hernia.

Various circumstances may tend to render a hernia *irreducible;* thus in a rupture of long standing, the neck of the sac, as was mentioned on a previous page, becomes constricted and smaller than its body, the *shape* of the hernia thus sometimes rendering it irreducible, particularly if the case be one of omental hernia in which the omentum is matted together into a dense conical mass; again, a hernia may become irreducible from the formation of *adhesions* between its contents and the interior of the sac, or, in the case of the herniæ of the cæcum or bladder (in which the sac is defective), between those viscera and the surrounding tissue.

Symptoms.—An irreducible hernia constantly tends to become larger, and causes inconvenience by its bulk and weight—the latter giving rise to an unpleasant, dragging sensation, with perhaps tormina, and disturbance of the digestive functions; moreover, an irreducible hernia is constantly exposed to the risk of becoming inflamed, obstructed, or strangulated.

Treatment.—This should consist in preventing the further increase of the hernia by the adaptation of a truss with a concave pad, or, if the rupture be very large, a "bag truss" or suspensory bandage. B. Cooper and other surgeons have succeeded in some instances in converting an irreducible into a reducible hernia, by keeping the patient in bed and on low diet for six or eight weeks, administering at the same time purgatives, with perhaps mercurial or antimonial preparations, and applying ice, sorbefacient unguents, or compression, to the hernial tumor. This plan could hardly be expected to succeed, unless in cases of omental hernia in which irreducibility was due solely to the shape of the protruded mass; and the treatment itself is so tedious and annoying that few patients can be found who are willing to submit to it. Elastic pressure, applied by means of an India-rubber bandage or bag, has proved successful in the hands of Maisonneuve, Collins Warren, and other surgeons. Velpeau, Bouchut, Guérin, and Pancoast, of this city, have resorted to subcutaneous division of the external ring or other seat of stricture, in these cases, the operation consisting in making a puncture through the skin and subcutaneous fascia, introducing a grooved director, which is insinuated beneath the source of constriction, and then dividing the latter with a curved bistoury passed along the groove and made to cut with a gentle rocking motion; an ingenious instrument for the same purpose (Figs. 429, 430) has been devised by Dr. R. W. Johnson, of Baltimore. It is evident from what was said concerning the development of the hernial sac, that in any case of long standing—and such only are as a rule permanently irreducible—it would be necessary to divide the neck of the sac itself (which would materially increase the danger of the operation), and that even then reduction could not be effected if adhesions existed between the sac and its contents. Hence the cases must be very few in number in which a prudent surgeon would feel justified in resorting to this procedure.

FIG. 429.

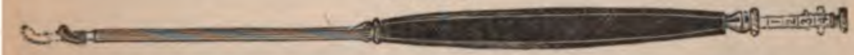
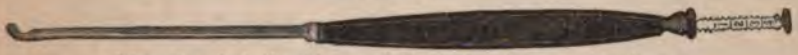


FIG. 430.



Johnson's probe-knife, with concealed blade, for subcutaneous herniotomy.

INFLAMED HERNIA.

Inflammation may attack a previously irreducible hernia, or may itself be the cause of irreducibility.

Symptoms.—These are essentially those of local, or in some cases of general, peritonitis, with constipation, but not complete obstruction, and occasionally vomiting, but not of a fecal character. The tumor is less tense than that of strangulated hernia, and the protrusion is less closely embraced by the edges of the opening through which it has passed. The inflammation may originate in the hernia, from the pressure of an unsuitable truss or from some other local cause, or may be secondary to an inflamed state of the alimentary canal. As the result of inflammation, adhesions are apt to form between the contents and sac of the hernia, rendering it permanently irreducible.

Treatment.—The patient should be put to bed, and, if his strength permit, a few leeches may be applied over the hernial tumor. Opium may be pretty freely given, in doses suited to the age of the patient, and if there be any tendency to general peritonitis, the anodyne may be properly combined with calomel. The application of an ice-bag, the skin being protected by the interposition of flannel, will often prove of the greatest service. The administration of cathartics should be strictly prohibited, but the action of the bowels may be solicited by simple enemata. The diet should be moderate in amount and unirritating in quality.

Littre and Birkett have described a variety of inflamed hernia in which a *limited portion of the wall of the bowel* becomes adherent to a small hernial sac, inflammation extending to the neighboring viscera, and thus ultimately inducing intestinal obstruction and death.

OBSTRUCTED OR INCARCERATED HERNIA.

A hernia is said to be *incarcerated* when the portion of bowel which it contains becomes obstructed by the accumulation of gas, or of solid or liquid fecal matter—a condition which was formerly supposed to be the cause of obstruction in cases of strangulated hernia. This condition is chiefly met with in old persons with chronically irreducible herniæ, and may be due to the impaction of a mass of cherry-stones or similar substances in the protruded gut.

Symptoms.—The symptoms are those of intestinal obstruction—moderate constipation, nausea, eructation, and perhaps vomiting—without any of the acute distress which accompanies strangulation; the tumor is painful and flatulent, but not particularly tense, and its gaseous and liquid contents may be sometimes pressed into the neighboring portions of the bowel by cautious manipulation, when solid masses of feces may perhaps be recognized by the touch.

Treatment.—This consists in the administration of purgative enemata, thrown up as far as possible by means of an O'Beirne's tube, so as to promote the natural peristaltic action of the bowels, opium being at the same time given in moderate quantities by the mouth. Ice may be applied to the tumor for a short time, the patient being kept in bed; and a cautious trial of the *taxis* (as will be presently described) may then be made, so as to at least partially empty the protruded bowel of its contents. When this has been accomplished (but not before), a cathartic may be given by the mouth. Should it be found that by this means the incarceration cannot be overcome, owing to the contracted state of the neck of the sac, it may be necessary to resort to *herniotomy*, either by the subcutaneous operation described in speaking of irreducible hernia, or by one or other of the methods ordinarily employed in cases of strangulation. It should never be forgotten, however, that *incarcerated*, unlike *strangulated, hernia* is essentially a chronic affection, and the surgeon should beware of converting it into one which is acute by a premature resort to the knife.

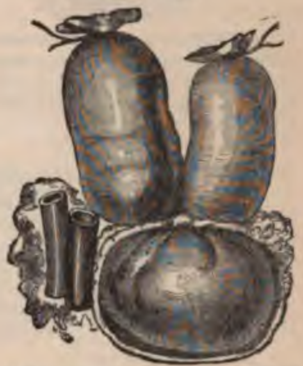
STRANGULATED HERNIA.

A hernia is said to be *strangulated*, when it is so constricted that its circulation is materially interfered with, inflammation and ultimately gangrene of the protruded viscus inevitably resulting, if the strangulation be not relieved. If the case be one of enterocele, the function of the strangulated portion of the intestine ceases, and obstruction of the bowel necessarily ensues; but if the omentum or vermiform appendix alone be involved, though there will be constipation, it may not be complete.

Causes of Strangulation.—In some cases, the occurrence of strangulation is preceded for several hours by a feeling of relaxation and weakness in the bowels, with perhaps a tendency to diarrhœa. Hence, Birkett believes, and probably with reason, that, in some instances at least, mechanical constriction is not the sole cause of strangulation, which may be partially due to a morbid action engendered in the tissues of the bowel itself. Strangulation usually results from the protrusion of an additional portion of the intestine into an already existing and perhaps irreducible hernia, or from the descent of a hernia which has been long restrained by a truss into a sac which has reached its ultimate stage of developmemt, that of contraction (see page 789); occasionally however, a hernia becomes strangulated when first protruded—this form of strangulation commonly occurring as the result of violent effort in young persons, and running a more *acute* course than that which occurs in large herniæ of long standing. Finally, a hernia which is at first merely obstructed or incarcerated, may eventually become strangulated by the gradual arrest of its venous circulation.

Mechanism of Strangulation.—The occurrence of strangulation was formerly attributed to spasm of the walls of the opening through which the hernia descends; as, however, the tissues which surround the neck of the hernial sac are in most instances fibrous or tendinous, the occurrence of spasm must be considered at least doubtful, though the contractile fibres which are said to have been found in cases of long standing (p. 789) might aid in causing strangulation. The mechanism by which this condition is induced, in most cases, is as follows: a segment of bowel or portion of omentum is suddenly extruded, under the influence of some violent effort, and being immediately compressed by the sides of the opening through which it has escaped, is prevented from returning; or from some morbid action in the alimentary canal generally, or in the peritoneal tissue, a previously existing hernia becomes congested, swollen, and temporarily irreducible; or the same effect may be caused by the accumulation of gaseous or fecal matter in the protruded bowel. Indeed, according to Lossen, the chief cause of strangulation is the continued pressure of fecal matter into the protruded gut through its afferent end which remains open, while the distal or efferent end is tightly closed. Whatever be the particular circumstances of the case, the contents of the hernial sac become congested, swollen, and œdematous, the disproportion in size between the protruded viscera and the orifice through which they have escaped, becoming momentarily greater. The constriction may be so tight as to deprive the strangulated part of vitality in a very short time, gangrene thus sometimes occurring in *acute* cases in the course of a few hours; under other circumstances gangrene is preceded by inflammation—and a patient with this *chronic* form of strangulation, may die of exhaustion and general peritonitis, without actual sphacelus having occurred.

FIG. 431.



Stricture in the neck of the sac, laid open. (ERICHSEN.)

Seat of Constriction.—This may be—1, external to the sac; 2, in the tissue of the sac itself; or 3, entirely within the sac.

1. In cases of recent hernia, in which the sac has not passed beyond the period of formation (p. 789), strangulation is commonly due solely to the compression exercised by the tissues external to the neck of the sac; this is usually the case in small strangulated herniæ which occur as the result of sudden efforts in young persons.

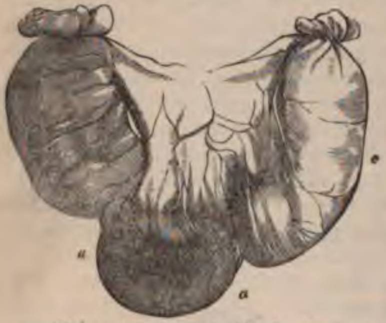
2. In a large number of instances, the neck of the sac itself is the seat of constriction: this is the case usually when the hernia has existed for a considerable time before the occurrence of strangulation. Occasionally, the seat of constriction may be in the body of the hernial sac, which may present an *hour-glass shape*, due either to a congenital peculiarity (p. 814), or to the formation of a recent sac above an old one, the neck of which has undergone contraction.

3. In some rare cases, the seat of constriction is entirely within the hernial sac, being due to the presence of bands of organized lymph; or strangulation may result from a knuckle of intestine being caught in a rent or pocket of omentum, in cases in which both are involved in the hernia.

Structural Changes resulting from Strangulation.—These are first manifested in the contents of the hernia itself, and subsequently in its sac and other coverings, and in the contents of the abdominal cavity.

1. *Changes in Contents of Hernia.*—The first effect of strangulation is to produce congestion of the strangulated part, followed more or less quickly by inflammation and gangrene. In cases of acute strangulation, the *bowel* may present a distinct groove at the part corresponding to the seat of constriction, and ulceration and perforation may take place at this point. The congested portion of intestine is swollen, of a "leathery" consistency, dark-red or brownish-purple in color, and often dotted with ecchymoses. In the stage of inflammation, patches of lymph may be observed on the peritoneal surface of the bowel, and the part feel sticky to the touch. As gangrene approaches, the serous covering of the intestine loses its natural lustre, the gut becomes soft and doughy, the color is a grayish-black, and the various layers of the bowel become readily separable from each other; ultimately the part gives way, and fecal extravasation occurs, resulting either in death or in the formation of a fecal fistula. Fortunately, before perforation occurs, adhesions have usually sealed the sides of the gut to the neck of the sac, so that the contents of the bowel do not enter the peritoneal cavity. The *omentum*, in the stage of congestion, presents a good deal of venous engorgement, assuming a reddish hue when inflamed, and becoming purple or grayish-yellow when gangrene supervenes. The *fluid* of the hernial sac is usually increased in quantity, and assumes a reddish-brown color from the transudation of blood, becoming cloudy, dark, and fetid, upon the occurrence of gangrene. *Hemorrhage* into the sac is occasionally met with, and, still more rarely, *suppuration* takes place, probably as the result of injury inflicted by the prolonged employment of the taxis.

FIG. 432.



a a, The portion of bowel which has been protruded; constricted, dark, and engorged. At *b*, the upper portion, dilated, and of dark color. At *c*, the lower portion, comparatively empty, flaccid, and pale. (LISTON.)

2. *Changes in Sac and Coverings of Hernia.*—The sac and its external coverings become inflamed, if the strangulation be not relieved, the skin over the hernial tumor becoming, on the approach of gangrene, of a reddish-purple hue, tender, doughy, and ultimately emphysematous, from the occurrence of mortification or the escape of gas from the ulcerated bowel; finally,

if the case be left to itself, sloughing will ensue, when the patient may possibly recover with a fecal fistula.

2. *Changes in Abdominal Cavity.*—The peritoneum always, probably, becomes inflamed when strangulation has persisted for any length of time, the inflammation usually assuming a diffused character, and being attended with the effusion of cloudy serum, and the production of ill-formed lymph or pus.

Symptoms of Strangulated Hernia.—These are either *local* or *constitutional.*

1. *Local Symptoms.*—If the hernia has existed for some time, it will be found, when strangulated, to be larger than usual, and somewhat painful, and if it contain bowel, to be tense, resisting, and semi-elastic to the touch; an omental hernia, however, may be soft and doughy, though strangulated; or if, as rarely happens, a recent hernia becomes strangulated behind an old and empty sac, the flaccidity of the latter may mask the tenseness of the former. The hernia is, of course, irreducible. There is no longer any impulse on coughing, the constriction preventing any fresh descent of bowel, and not allowing the shock of coughing to be transmitted to the hernial contents—a fact which suggested to Luke an ingenious plan of determining the seat of strangulation, by noting the exact point at which the impulse ceased to be felt. The hernia may continue to increase in size, after the occurrence of strangulation, from the effusion of serum into the sac; this is particularly observed in cases in which the taxis has been repeatedly, though fruitlessly, employed. On the approach of gangrene, the hernial tumor, as already mentioned, presents the ordinary signs of inflammation, and, in some instances, suppuration or sloughing may ensue.

2. *Constitutional Symptoms.*—These are referable to *obstruction of the intestine,* and to subsequent *inflammation* of the sac and peritoneum.

(1.) The symptoms of *intestinal obstruction* are essentially the same, whatever may be the cause of obstruction; they consist of griping pains about the umbilicus, a sense of constriction, with flatulence, tympanites, tenesmus, constipation, nausea, and vomiting. There may be one or two passages from the lower bowel after the establishment of strangulation, and, if the hernia be altogether omental, there may not be at any time complete constipation. There is also a variation in the degree to which vomiting is present; in some cases early and profuse, in other cases there may be merely slight nausea, as long as the patient is quiet, though even in these instances vomiting may be induced by the administration of liquids. The matter ejected consists at first of the contents of the stomach, next of the gastric fluids, mixed with regurgitated bile, and ultimately of the intestinal contents, the vomiting then being called fecal or stercoraceous. As the patient becomes exhausted, and particularly if opium has been freely given, the vomiting may subside; the surgeon should not, however, be deceived by this delusive calm, which is really indicative of a most dangerous condition; the pulse now becomes feeble, the surface cold, and the extremities shrivelled, while the countenance assumes a pinched and anxious expression. Death may ensue in this stage, or, on the other hand, the extreme relaxation may allow reduction to be readily accomplished.

(2.) The symptoms of *peritonitis,* when this condition is fully developed, are commonly well marked. Often, however, there are but little pain and tenderness, and but for the peculiar small and wiry pulse, and anxious countenance, the existence of peritoneal inflammation might not be recognized. Upon the occurrence of gangrene, the patient falls into a state of *collapse:* the pain suddenly ceases, the skin is cold and bathed in a clammy sweat, the pulse is weak and running, sometimes intermitting, and death may be preceded by slight delirium. The period at which the inflammatory symptoms occur is a matter of some importance. In a case of *acute* strangulation (page 797), such as is met with in young persons as the result of violent exertion, inflammation sets in early, and may terminate in fatal gangrene in the course of a few hours; while, if the strangulation be of a more *chronic* character, the symptoms of obstruction may last for several days before the occurrence of any serious inflammatory changes; hence, while in the former case an early operation is imperative, in the latter more time may be properly spent in a trial of other measures.

Diagnosis of Strangulation.—A *strangulated* may usually be distinguished from an *incarcerated* hernia by noting the absence of impulse on coughing, the persistent vomiting and stercoraceous character of the matters ejected, and, in an acute case, the sudden onset of the symptoms. From an *inflamed* hernia, or from *general peritonitis coexisting with an irreducible hernia*, it may be distinguished by observing the character of the vomit and the completeness of the constipation. In a case of merely coincident peritonitis, moreover, the point of greatest tenderness may be at a distance from the hernial sac. The *vomiting of pregnancy*, if the patient have an irreducible hernia, may simulate strangulation, but may be distinguished by observing the nature of the matter ejected (which is never stercoraceous), and the absence of complete constipation. The coexistence of an irreducible hernia with *intestinal obstruction* from another cause, may deceive the most skilful surgeon, the existence of an impulse on coughing being, in such a case, probably the only symptom to distinguish it from one of strangulation. If there be *two or more herniæ*, one only of which is strangulated, it will probably be found that there is most tension and tenderness about the neck of that which is the seat of constriction. Certain *tumors*, as for instance an inflamed lymphatic gland, occurring in one of the common localities of hernia in connection with the rational symptoms of strangulation, may closely simulate the latter condition, and the true state of the case may be only revealed by making an exploratory incision. *Inflammation of an undescended testicle* may be distinguished from strangulated hernia, by observing the absence of the gland from the corresponding side of the scrotum.

Prognosis.—In cases of acute strangulation (page 797), the prognosis is extremely grave, ulceration and gangrene sometimes occurring in the course of a few hours. In chronic strangulation, there is less immediate danger, though the affection is always one of a very serious character. It is difficult to estimate properly the death-rate of strangulated hernia, from the fact that the operation, which, in many, if not most, cases affords the only chance of life, is unfortunately too often postponed until death is inevitable under any circumstances. I cannot subscribe to the dogma, which has been recently promulgated by high authority both at home and abroad, that surgeons generally are too prone to operate in cases of strangulated hernia. I am well convinced, on the contrary (and in this view I am sustained by the almost unanimous testimony of hospital surgeons of large experience), that lives are constantly sacrificed by the hesitancy which many medical men feel in resorting to herniotomy; and yet this is an operation which, like tracheotomy, every *physician*, as well as every *surgeon*, should feel himself competent to perform. While no one can deprecate more than I do a premature resort to the knife, I firmly believe that many lives would annually be saved, were the profession, as well as the public, more aware of the dangers attending a strangulated hernia, and of the responsibility which attaches to him who undertakes its treatment. This much is certain: that every strangulated hernia, if not relieved in a variable, but always brief, period, will almost inevitably cause the death of the patient; and that, if a moderate and cautious employment of the taxis does not afford relief, the sole hope of safety lies in the use of the knife—the operation, moreover, not, as a rule, adding anything to the danger of the case, though, from being postponed until too late, it unfortunately often fails to save life. Birkett estimates the proportion of patients lost by delay as being two-thirds of those who die after the operation, and judiciously advises that the surgeon should not feel himself justified in leaving, for any length of time, a case of strangulated hernia, until the constriction has been, in one way or another, relieved.

Even in a case in which the diagnosis is not quite clear, an exploratory incision may be highly proper, and the oft-repeated rule, "when in doubt, operate," is unquestionably founded on sound surgical principles.

Treatment of Strangulated Hernia.—The two principal methods employed in the treatment of strangulated hernia are *the taxis* and *herniotomy*. There are, besides, certain auxiliary measures, which are employed either before resorting to, or in connection with, the taxis. It is of the utmost importance, in regard to treatment, that the surgeon should distinguish between the two conditions which have been referred to as *acute* and *chronic* strangulation.

In the *acute* form (which, it may be repeated, usually occurs in young persons, often as the result of sudden and violent exertion, the hernia itself being commonly of small size) but little time is allowed for the employment of expectant treatment; and if the intensity of the constitutional disturbance, the restlessness and anxiety of the patient, and the constant vomiting, with pain and other evidences of threatening inflammation, show the case to be one of this class, the surgeon should resort at once to the taxis, aided by the induction of complete anæsthesia, with the understanding that, if a moderate trial of this method prove unavailing, herniotomy is to be immediately proceeded with.

If, on the other hand, the case be one of *chronic* strangulation (which is usually met with in old persons who have long been ruptured, in which the hernia is comparatively large, and in which the symptoms are at first simply those of obstruction), the necessity for immediate action is less urgent. If no vomiting have occurred, or if merely the contents of the stomach have been rejected without there having been any regurgitation from the bowels, it may even be proper to postpone the taxis, and try the effect of rest, position, and cold, with the internal administration of opium. The patient may be placed in bed, with the hips elevated and the knees flexed, the scrotum (in a case of scrotal hernia) being well supported, and an ice-bag, guarded by flannel, applied over the neck of the sac and adjacent parts. The lower bowel may be emptied by the use of an enema, and a full dose of opium or morphia given by the mouth (or by the rectum if there be much nausea), the room being then darkened and the patient left to sleep. Upon the surgeon's return, after an interval of four, six, or eight hours, according to the greater or less urgency of the case, he will often find that reduction either has been spontaneously accomplished, or is readily effected by slight manipulation. It is impossible to lay down any positive rule as to the length of time during which this expectant mode of treatment may be properly employed, but probably twenty-four hours may be given as an extreme limit; at the end of this period, or before (if urgent symptoms should arise), the patient should be thoroughly anæsthetized, and then, if the taxis fail, the surgeon should at once proceed to the operation.

The above remarks are based upon the supposition that the surgeon has had the opportunity of directing the treatment of the case from the very beginning. It unfortunately happens, however, that, in many instances, precious time is wasted on account of the ignorance or obstinacy of the patient, or still worse, that his condition has been greatly aggravated by ill-judged and perhaps violent efforts at reduction by himself or others. The surgeon is often not called to the case until ulceration or gangrene of the gut is impending, if, indeed, it has not already occurred. Under such circumstances, an operation is, of course, the only treatment admissible. In any case, if the matters vomited be colored with bile, showing that intestinal regurgitation has begun, and still more if the vomiting be stercoraceous, no time should be lost in relieving the constriction, and if the taxis have been already fairly tried by another practitioner, it may, under these circumstances, be even proper to operate without its repetition. As justly remarked by Birkett, "The vital importance of liberating the bowel from constriction, at the earliest moment, cannot be overestimated. As upon the speedy accomplishment of this the salvation of life depends, a little precipitate action may even be forgiven, so hazardous is the position of a patient with the bowel strangulated. But what is the risk attending the operation of exposing the hernial sac, dividing the impediment to the reduction of the hernia, and reducing it, even should the peritoneal sac require to be opened? Practically none. In comparison with that of leaving the bowel strangulated, it is harmless."

THE TAXIS.[1]

This is the name given to the various manipulations by which the surgeon endeavors to effect the reduction of a hernia without resorting to any cutting operation. The ordinary and commonly the best mode of applying the taxis is as follows: The patient being thoroughly anæsthetized, in the recumbent posture, with both the shoulders and hips slightly raised, the thighs adducted and flexed (so as to relax the abdominal muscles), and the bladder and rectum emptied, the surgeon fixes the orifice and neck of the hernial sac, by surrounding the corresponding part of the tumor with the thumb and fingers of the left hand, while with the palm and fingers of the right he gently compresses the body of the tumor, so as, if possible, to empty it of some of its gaseous or fluid contents. Then drawing down the tumor a little, so as to dislodge the hernia from the constricting neck of its sac, and draw down the mesentery, which, as pointed out by Berger, acts as a conical plug in impeding reduction, he attempts, by a combination of gentle kneading, rolling, and compressing movements, to return the protruding viscera into the abdominal cavity, the line of pressure strictly corresponding to that by which the hernia came down, and that portion of the hernial contents being first replaced which last descended. The success of the manipulation is made apparent by the disappearance of the tumor with the peculiar gurgling and slipping sensation which has been already referred to as characterizing the reduction of a hernia (p. 791).

The mode of applying the taxis above described may be advantageously varied in certain cases; thus, if the seat of constriction be not hidden by the thickness of the superincumbent fat, the surgeon may attempt to dilate the hernial aperture, by introducing the tip of the finger or the finger-nail, and drawing the edge of the ring to one side, while pressure on the tumor is maintained with the other hand. This plan, the suggestion of which is attributed to Seutin, is chiefly applicable in cases of femoral hernia, and should only be tried in cases of quite recent strangulation, for if the constricted bowel were already softened by inflammatory changes, the pressure of the finger might possibly lead to serious consequences; a somewhat similar manœuvre has recently been recommended by P. C. Smyly, of Dublin; and H. R. Allen, of San Francisco, has devised a special instrument for effecting the same purpose. In some cases, in which the ordinary taxis fails, taxis with *inversion* may succeed. This consists in drawing the lower extremities and body of the patient upwards in a vertical direction, while the shoulders rest on the bed, thus bringing the force of gravity to aid the manipulations of the surgeon. The same end may be sometimes attained with less discomfort to the patient by simply elevating the pelvis, and practising slow and gentle frictions of the abdomen, in a direction from below upwards, so as to encourage the recession of the viscera from the seat of constriction. Again, success may be occasionally attained by causing the patient to lie on one or other side in a semi-prone position (as advised by Gay, of Buffalo), by placing him on his elbows and knees, or by directing him to stand erect, or to lean forwards over the back of a chair. In a case admitting of procrastination, any or all of these plans may be tried before resorting to severer measures. A curious case is recorded by Froumüller, in which reduction of an umbilical hernia was effected by the application of an exhausted cupping-glass; the sac and overlying tissues rose into the glass to fill the vacuum, and the strangulated gut instantly slipped back into the cavity of the abdomen. A similar plan is recommended by Dr. Washington, of Nashville.

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[1] From the Greek *τάξις*, from *τάσσω*, I arrange or put in order.

Dr. Hadden, of New York, records a case of inguinal hernia in which the taxis was aided by introducing the left hand through the rectum into the descending colon, and making traction upon the incarcerated bowel.

The taxis should invariably be practised with the utmost caution and gentleness; forcible squeezing and pushing is not at all likely to be productive of the slightest benefit, while it will almost certainly, by increasing the tendency to congestion, hinder reduction, and may not improbably lead to a serious and perhaps fatal termination. The *time* during which the taxis may be employed should not, as a rule, exceed from a quarter to half an hour on each occasion; if on its first trial it do not prove successful, and if the urgency of the case admit of delay, a trial should be given to opium, cold applications, etc., in the way already described, the taxis being renewed after some hours' interval; if the second attempt also fail, herniotomy should ordinarily be at once resorted to.

Adjuvants to the Taxis.—Of these the most valuable is unquestionably *anæsthesia*. Chloroform is preferred to ether by many surgeons, as being less likely to provoke vomiting; but as the fullest effect of the anæsthetic agent is required, ether is probably safer, and will, I believe, be found quite satisfactory. Etherization should be pushed not only until the patient is insensible to pain, but until complete muscular relaxation is induced. *Venesection* was formerly much employed in these cases, the bleeding being sometimes carried *ad deliquium*, but since the introduction of anæsthetics is comparatively seldom resorted to; the same may be said of the use of the *tobacco enema*, an uncertain and dangerous remedy. The *warm bath* is often an efficient adjuvant to the taxis, and may be properly used in hospitals, or wherever there are facilities for its employment, as a preliminary to the taxis in acute cases. The patient may be kept in a bath of a temperature of about 95° Fahr., until some relaxation or faintness is induced, when he should be wrapped in blankets and immediately etherized. The taxis is then employed, and, if this fail, herniotomy. The warm bath is less applicable in cases of chronic strangulation, in which it seems, sometimes, to increase the tension and bulk of the hernial tumor. The local application of *cold*, by means of the ether-spray, or in the form of an ice-bag guarded by flannel, is often of great use in cases admitting of some hours' delay, in conjunction with a *position* which insures relaxation of the abdominal walls, and the internal administration of *opium* (see page 801). The hypodermic injection of *atropia* has been successfully resorted to by a French surgeon, Dr. Rahn, and that of *morphia* by Dr. Philippe. Planat, of Nice, recommends the use of *ergot*, both internally and as a local application. Pressure by means of an *elastic bandage* appears to have been originally suggested by Maisonneuve, and has been occasionally employed with advantage. *Purgatives* are very commonly taken by patients on their own responsibility, or by the prescription of non-professional advisers, but can exercise only an injurious influence. They may, as already mentioned, be of service in the treatment of *incarcerated hernia* (p. 796), but should be strictly interdicted when actual strangulation exists. A *purgative enema* of castor oil and oil of turpentine, suspended in gruel or soapsuds, may, however, be properly administered in a case of chronic strangulation, with a view of emptying the bowel below the seat of constriction, and thus, by lessening the distension of the abdomen, facilitating the reduction of the hernia. Puncturing the hernia by means of a delicate trocar,[1] with or without the subsequent use of an "aspirator," so as to diminish the tension of the strangulated gut by withdrawing its gaseous and even its liquid contents, has been recommended by Dieulafoy, Fonssagrive, Duplony, Autun, Chauveau, and other surgeons. Unsuccessful cases have, however, been recorded by Doutrelepont, Madelung, Fleury, Verneuil, and Panas, and there is reason to believe that the operation is not as free from risk as was at first supposed. *Inflation of the bowel* by the use of bellows has been successfully employed by Dr. Joy, of Tamworth, and other surgeons, the distension of the gut apparently producing a *vis a tergo* which draws back the strangulated portion; and with a similar object Torres has oddly suggested the use of successive enemata of bicarbonate of sodium and tartaric acid, so as to insure a free formation of gas within the intestine.

Management of the Case after Reduction.—The symptoms of strangulation commonly disappear immediately or very soon after the accomplishment of reduction; all that is then necessary is to apply a compress and bandage to prevent the re-descent of the hernia, and to keep the patient in bed until any constitutional disturbance that may be present has subsided. If the bowels are not moved spontaneously in the course of two or three days, an opening enema may be administered.

Persistence of Symptoms after Reduction.—It occasionally happens that, though the hernial tumor has disappeared under the use of the taxis, the symptoms of strangulation still continue: this may arise from the occurrence of what is called *reduction in mass* (only met with in inguinal hernia); from the gut having been so tightly constricted as to be more or less completely *paralyzed*, in which case gangrene will probably follow; from the existence of *strangulation within the sac* (as from the existence of internal adhesions, or from a knuckle of intestine being caught in a pocket of omentum, in a case of entero-epiplocele); or from the coexistence of a *second strangulated hernia* in another locality.

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[1] This mode of treatment was described by Peter Lowe, in the early part of the seventeenth century.

1. *Reduction in Mass (en bloc).*—This name is commonly applied to several distinct pathological conditions.

(1.) The whole hernia may be pushed back behind the abdominal walls, into a space formed by the separation of these from the parietal peritoneum; this is a very rare accident, according to Birkett, who believes that more frequently only the neck and mouth of the sac are detached from their external connections, the scrotal tissues being pushed up with the body of the sac, which then lies partially within the inguinal canal. In either case, the strangulation is maintained by the neck of the hernial sac.

(2.) The neck of the sac may give way under forcible pressure, the hernia as a consequence escaping into the subserous areolar tissue, where it forms a pouch for itself between the peritoneum and the internal abdominal fascia.

(3.) There may be an *intra-parietal sac*, or rather the sac may consist of two parts which are separated by a contracted portion; if the seat of strangulation be at the ventral orifice, the hernia may be pushed from the outer into the inner or intra-parietal sac (which is situated in the abdominal wall), the tumor as a consequence disappearing, though the strangulation still continues.

The occurrence of reduction in mass is not attended with the gurgling sound and sensation which is characteristic of the return of a hernia from its sac into the cavity of the abdomen; and hence, if this sign should in any case be absent, the surgeon would at once suspect that the accident in question had happened. If reduction in mass should have taken place before the surgeon is called to the case, he would be forced to rely mainly upon the history of the accident, in making a diagnosis, though if the whole hernia were within the abdominal wall, he would be aided by observing that there was no fulness of the part such as would be caused by the sac remaining *in sitû*, and that the inguinal canal and abdominal rings were unusually patulous. In the case of rupture of the neck of the sac, or of the existence of an intra-parietal sac, these signs would of course be absent.

The *treatment* of reduction in mass consists in directing the patient to cough, so as if possible to cause the re-descent of the hernia (when herniotomy should be at once performed); or, if this fail, in making an exploratory incision, exposing the abdominal ring, prolonging the wound if necessary into the inguinal canal, laying open the sac of the hernia, and dividing the neck of the sac or other source of constriction.

2. *Paralysis of the Bowel.*—This condition may be suspected if the symptoms of strangulation continue in spite of reduction *attended with the characteristic gurgle*, so often referred to. Under these circumstances, the surgeon should wait for a few hours, for it may be that the constriction, though sufficient to cause temporary paralysis of the gut, has not impaired its vitality, in which case the vomiting will by degrees lose its stercoraceous character, the tympanites subside, and all the symptoms of strangulation gradually disappear; to operate under such circumstances, would expose the patient to a totally unnecessary risk. If, however, the symptoms persist with unabated violence for several hours, the best that can be done is to lay open the hernial sac and deal with the gangrenous intestine (if this can be found) in the way which will be presently described, or, as a last resort, to cover the wound with a light poultice, in the hope that when the gut sloughs the patient may recover with a fecal fistula.

3. *Internal Strangulation.*—The symptoms in this case, if the hernia were inguinal, might be indistinguishable from those of reduction in mass; the hernial sac could, however, always be felt in the inguinal canal, and there would be no undue patulousness of the abdominal rings. The *treatment* would consist in laying open the sac, and in searching for and removing the cause of constriction, dividing bands of adhesion, and *unravelling*, as it were,

the omentum, by the folds of which the strangulation might probably be caused; if it should be found that the seat of constriction was not within reach, the case being one of internal strangulation and the existence of the hernia a mere coincidence, the surgeon would, in my opinion, be justified in extending the incision upwards into the abdominal wall, so as to allow a careful exploration of the adjacent intestine; by such a proceeding, Bryant was enabled to discover and divide a fibrous band which produced internal strangulation, and thus saved his patient's life. A similar operation in my own hands was effective in relieving the strangulation, though the patient ultimately died from peritonitis.

4. *Coexistence of another Hernia.*—If a second hernia should exist in a state of strangulation (which could be ascertained by a careful examination of the various parts in which herniæ may occur), it should of course be at once reduced by the taxis, or, if necessary, by herniotomy.

Rupture of the Intestine.—This is the most serious complication which can follow the employment of the taxis, and is only likely to ensue when the force used has been very great; it must not be forgotten, however, that a portion of bowel which has been strangulated for twenty-four hours or longer, is very much softened, and will give way under much slighter pressure than in its normal condition. The signs by which the occurrence of this accident may be recognized are sufficiently obvious; the hernia disappears, but without the characteristic gurgle which is perceived when reduction is properly accomplished, and the development of intense abdominal pain, with hiccough and collapse, indicates the occurrence of fecal extravasation into the peritoneal sac. Death is inevitable, unless, as rarely happens, adhesions should have previously shut off the part from the general cavity of the peritoneum, when recovery with a fecal fistula may possibly ensue. The only admissible *treatment* would consist in laying open the hernial sac, so as to facilitate the latter termination.

HERNIOTOMY OR KELOTOMY.

There are two principal modes of operating for the relief of strangulated hernia, in one of which the hernial sac is, and in the other of which it is not, opened. The latter, which is sometimes known as Petit's operation, is preferable in certain selected cases, and will be referred to in its proper place. Instead of operating at the seat of hernia, it has been recommended to open the abdominal cavity at a neighboring point and endeavor to draw the strangulated gut backwards out of the hernial sac. The introduction of this mode of operating has been incorrectly attributed to Cheselden; it has been, as far as I know, resorted to (intentionally) in but two cases[1], by Annandale, and both of those cases terminated fatally.

Herniotomy Opening the Sac.—The ordinary operation, in which the sac is opened, is thus performed. The patient is thoroughly anæsthetized, his bladder and rectum emptied, and the hair removed from the seat of operation. The surgeon makes his first incision, from two to four inches long, through the skin and superficial fascia over the neck of the sac, either by transfixing a fold of integument and cutting from without inwards, or, which I prefer, by simply cutting down as if for the removal of a tumor. After the first incision, the operator should proceed cautiously, picking up each successive layer of tissue with forceps, and notching it, so as to introduce a grooved director, upon which it is then to be slit up; any artery that bleeds should be at once secured. When the sac is reached, it is in the same way picked up (at its anterior and lower part) with delicate forceps or a tenaculum, notched by a light touch of the knife laid flatwise, and then slit up upon a broad director. The sac may be usually recognized by its tension, its rounded, semi-translucent appearance, its fibrillous structure, and the arborescent distribution of its vessels. A flow of serum commonly marks the opening of the sac. The next step is to divide the source of constriction; this is effected by passing the left forefinger up to the neck of the sac (Fig. 433), and insinuating the nail beneath the tense edge (drawing the coil of intestine slightly downwards, if necessary, for the purpose), and then introducing flatwise, along the palmar surface of the finger, a probe-pointed "hernia-knife" with a limited cutting edge (Fig. 434); by turning the edge forwards, as soon as the blade has entered the stricture, the latter may be readily divided, an incision of from two to three lines being usually quite sufficient. If the stricture will not admit the finger-nail, a grooved director must be substituted. As soon as the constriction is relieved, the surgeon examines the contents of the hernia, dealing with bowel and omentum according to the condition in which each is found; if their state be satisfactory, reduction is cautiously effected, the gut being first returned, and the edges of the sac held in place so as to avoid the accident which has been referred to as reduction in mass. The finger should then be cautiously introduced into the abdominal cavity, to make sure that the constriction has been removed, when the wound may be closed at its upper part with a few stitches, and a compress and bandage applied. The lower part of the wound should always be left open to secure free drainage, the subsequent dressings being varied according to the exigencies of each particular case.

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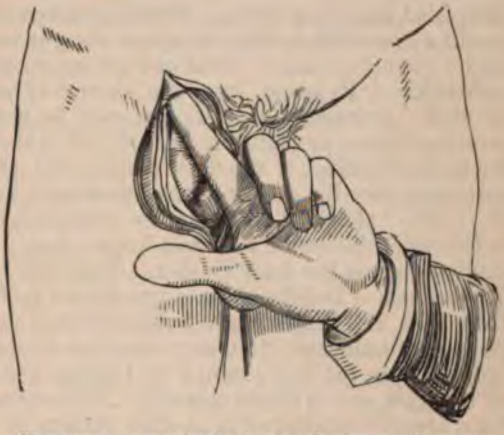
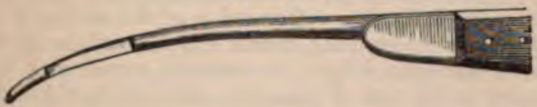
[1] Two cases are, however, known in which laparotomy was employed in the treatment of unrecognized *obturator* hernia.

FIG. 433.



Herniotomy: searching for the seat of stricture. (LISTON.)

FIG. 434.



Hernia-knife.

The after-treatment consists in keeping the patient in bed, and under the influence of moderate doses of opium, liquid diet only being allowed for four or five days. If the bowels are not moved spontaneously, a simple enema may be given after forty-eight hours, and repeated when necessary, but the administration of purgatives by the mouth should be avoided.

Treatment of Complications.—Various complications may arise during the performance of herniotomy or subsequently, the treatment of which must now be briefly considered.

Treatment of Intestine.—If the bowel contained in a strangulated hernia be merely *congested*, it should be gently returned into the abdominal cavity, in the way already directed. If it be *inflamed*, and present a distinct *groove* or *sulcus* corresponding to the seat of constriction (see page 798), it should be left, after division of the stricture, at or near the orifice of the hernial sac, so that if, as is likely to happen, perforation ensue, the part will be in the most favorable position for the formation of a fecal fistula. Bourguet, of Aix, advises that the gut should be fixed at the level of the internal wound by means of catgut sutures. The external wound should be lightly dressed with oiled lint or a poultice. If the bowel be absolutely *gangrenous*, it should be slit up and left *in sitû*; to return the gut in this condition would be to insure the occurrence of fecal extravasation, and the development of fatal peritonitis. In every case, the source of constriction should be freely divided. A *wound of the intestine* may be accidentally inflicted, either in opening the sac prematurely or in dividing the stricture, if a grooved director be used instead of the finger-nail in this part of the operation, the gut spreading over the groove of the instrument, and thus coming in the way of the knife. Hence, if a director be employed, the surgeon should see that it is free from the bowel, and then keep it firmly pressed against the stricture, until the latter has been divided. To avoid the risk of wounding the gut, Richardson, of Dublin, has recommended a knife with a broad flange attached to its back, and projecting in front and on either side, thus serving the double purpose of knife and director; somewhat similar instruments have been also employed, in the last century by Ledran, and more recently by Patterson, of Glasgow, and Allis, of this city. The *treatment* of wounded intestine has been already considered in another portion of the volume (see page 380).

Treatment of Omentum.—If the omentum found in the hernial sac be but small in quantity, and unaltered in structure, though congested, it should be returned into the abdominal cavity. If thickened, and indurated, it should, on the other hand, be left in the sac, as it is apt in this state to become inflamed, and its reduction would probably lead to the development of general peritonitis. If, in addition, the protruded omentum be deeply congested, it should, as a rule, be excised, and this should invariably be done if the omentum be inflamed or gangrenous. Excision is effected by transfixing the base of the constricted omentum with a double ligature, tying it in two parts so as to avoid hemorrhage, and then cutting off the mass below the seat of ligation. Retraction of the stump is prevented by bringing the ligatures through the wound, and fixing them on the abdominal wall by means of adhesive strips; the external wound may be closed over the stump, except in the case of gangrene, when it should be left open and simply dressed with a light poultice. If an *ovary* be found in the sac, it may be dealt with in the same manner as the omentum.

It is perhaps scarcely necessary to say that before excising any portion of omentum, it should be thoroughly unravelled, and carefully examined, to make sure that no portion of gut is entangled in its folds. Any *cysts* that may be found may be treated by simple puncture.

Irreducibility after Operation.—It sometimes happens that, though the constriction is relieved, the hernia cannot be reduced; this is usually owing to the existence of *adhesions* between the protruded bowel and the inner surface of the sac, but may occasionally be due to extreme *distension of the intestine itself.*

(1.) *The Management of Adhesions* depends chiefly on the state of the bowel; if this be in a condition to admit of its being returned into the abdominal cavity, the adhesions should, as a rule, be gently separated with the finger or handle of the knife, or, if necessary, cautiously dissected through. In some instances, however, the adhesions may be so broad and firm as to render it proper to leave the intestine unreduced. In case the bowel be ulcerated or gangrenous, the adhesions around the neck of the sac should be scrupulously respected, as upon them depends the prevention of fecal extravasation into the peritoneum. Bands of adhesion passing between the gut or mesentery and the omentum, should be carefully divided, as they may be the real source of constriction (pp. 798, 805); the operation must be done with great care, to avoid the risk of wounding the intestine.

(2,) *Distension of the Bowel* by an accumulation of gas, may impede reduction, particularly if the gut contain a large quantity of indurated fecal matter as well. The *treatment* consists in making one or more punctures with a very fine trocar, as has been successfully done by Tatum, of London, and by several German surgeons.

Hemorrhage.—It sometimes happens that, from an abnormal distribution of a vessel, or from other causes, serious arterial hemorrhage arises when the neck of the hernial sac is divided. The *treatment* consists in enlarging the wound and securing both ends of the bleeding vessel. If the proximity of an artery be suspected, Erichsen advises that the edge of the hernia-knife should be dulled by drawing it over the back of the scalpel; it will then push the artery before it, though still sharp enough to relieve the strangulation. Corley and Hayes, both surgeons of Dublin, have devised special knives designed to avoid the risk of dividing an artery in this operation, but the instruments seem to me unnecessarily complicated.

Complications arising during the After-Treatment.—The most important of these are the development of *peritonitis*, which usually assumes a diffused character, and the formation of a *fecal fistula*. For the *treatment* of these conditions, see pages 378 and 382. *Sloughing of the hernial sac* is a rare occurrence, and one which is very apt to prove fatal; its *treatment* presents no features calling for special comment.

Herniotomy without Opening the Sac (**Petit's Operation**).—This method was employed in the early part of the last century by Petit, and has been particularly advocated by Aston Key, Luke, and other British surgeons. It is now generally acknowledged to be the most eligible procedure when the circumstances of the case allow a choice of operations. It is attended with the obvious advantage of not involving the peritoneum, and of therefore exposing to less risk of the occurrence of peritonitis; but, on the other hand, with the disadvantage of not allowing the surgeon to determine by inspection the condition of the protruded viscera, and of possibly permitting a continuance of strangulation by the occurrence of reduction in mass or by leaving internal adhesions undivided, etc. It is of course only applicable to those cases in which the seat of constriction is external to the sac (p. 797); but as this point cannot always be determined beforehand, this mode of operating should be tried in every instance in which the duration of strangulation and the urgency of the symptoms do not contra-indicate its employment. A safe rule is that given by Birkett—to try this method in those cases and those only in which the taxis would be deemed justifiable. If after exposing the sac and dividing the tissues external to its neck, the hernia be found still irreducible, or (in the case of an old irreducible hernia, recently strangulated) the symptoms of strangulation still continue, it is easy to open the sac and complete the operation in the ordinary way.

Petit's method is particularly applicable in cases of femoral and umbilical hernia, but should be attempted in those of inguinal hernia as well. It is especially desirable to avoid opening the sac in large herniæ which have been long irreducible, and in which strangulation is due to the protrusion of a fresh portion of gut.

The statistics of this operation are very favorable, the mortality being, according to the figures given by Erichsen, but 23.5 per cent., as compared with a mortality of 47.7 per cent. after the ordinary operation. It must be remembered, however, that Petit's method is only resorted to in selected cases.

Gay's Modification of Petit's Method consists in making a small opening near the neck of the sac, introducing the finger to search for the seat of constriction, and upon the finger a concealed bistoury, the point of which is cautiously insinuated between the neck of the sac and the stricture; by then protruding the blade of the instrument, division is effected. This method will be again referred to in speaking of femoral hernia, to which it is chiefly applicable.

CHAPTER XLI.

SPECIAL HERNIÆ.

The following classification of the various forms of abdominal hernia, according to their locality and anatomical peculiarities, is based upon that given by Birkett, in his excellent monograph in Holmes's System of Surgery, but is modified and slightly extended, in the hope that it will thus be more readily understood by the student.

CLASSIFICATION OF HERNIÆ.

Herniæ in the Epigastric Region.

1. Diaphragmatic.
2. Epigastric.

Herniæ in the Mesogastric Region.

1. Ventral. [This form may also occur in other regions.]
2. Umbilical.
3. Lumbar.

Herniæ in the Hypogastric Region.

- **I. Inguinal.**
  - 1. *Oblique.*
    - (1.) In the male.
      - *Herniæ of sudden development.*
        - (*a.*) Into the vaginal process of peritoneum.
        - (*b.*) Into funicular portion of vaginal process.
        - (*c.*) Inguino-crural, etc.
      - *Herniæ of gradual development.*
        - (*a.*) Inguino-scrotal.
        - (*b.*) Encysted.
    - (2.) In the female.
      - (*a.*) Into the canal of Nuck.
      - (*b.*) Inguino-labial.
  - 2. *Direct.*
- **II. Femoral or Crural.**
- **III. Pelvic.**
  - 1. *Anterior.* Obturator.
  - 2. *Inferior.*
    - (1.) Perineal.
    - (2.) Pudendal.
    - (3.) Vaginal.
  - 3. *Posterior.* Ischiatic.

The pathology and treatment of each of these forms of hernia are now to be briefly considered.

Diaphragmatic Hernia.

In this rare form of hernia, some of the abdominal viscera protrude into the thoracic cavity. The protrusion may occur through one of the diaphragmatic orifices which has undergone dilatation, through an aperture resulting from congenital defect of development, or, which is most common, through a laceration or wound of the part. The affection is seldom recognized during life, the symptoms being necessarily of a very equivocal nature; even if strangulation should occur, the diagnosis from other forms of intestinal obstruction could rarely be made out, and the *treatment*, consequently, would be chiefly expectant.

Epigastric Hernia.

In this variety of the disease, the protrusion occurs in or near the linea alba, between the ensiform cartilage and the umbilicus. Reduction is usually easy. The *treatment* consists in the application of a pad and elastic bandage. If strangulation occur, and herniotomy be required, care must be taken to divide the stricture by an incision made in the direction of the long axis of the body, and exactly in the median line, so as to avoid wounding the epigastric artery. This variety of rupture may be properly considered as a form of *Ventral hernia*, though the latter term is here applied more particularly to similar herniæ in the mesogastric region.

Ventral Hernia.

This may occur in the linea alba or lineæ semilunares, or indeed in any part of the abdominal wall. It may result from rupture of the abdominal muscles (p. 375), from wounds, or from stretching of the fibrous tissue in the median line—due to over-exertion, to distension from pregnancy, etc., or to weakening of the part by the discharge of an abscess. The diagnosis can readily be made if the hernia be reducible, but under other circumstances the affection may be mistaken for a cold abscess, an enlarged lymphatic gland, or a cystic or fatty tumor, from any of which, however, it may be distinguished by careful palpation and inquiry into the history of the case. The *treatment* consists in the application of a suitable truss or bandage. Strangulation rarely occurs in this form of hernia. For the *radical cure* of hernia of the linea alba, Simon, of Heidelberg, freshened the edges of the opening, and united them by deep and superficial sutures, relieving the tension of the parts by making incisions on either side.

Umbilical Hernia.

(*Exomphalos, Omphalocele, Ruptured Navel.*)

In this variety of hernia, the protrusion occurs through, or in close proximity to, the umbilical ring or navel. Occasionally congenital, it is more commonly acquired, appearing usually during the early months of infancy, but sometimes not until adult life; it is probable, however, that in many, if not most, of the latter cases, the umbilical ring has been patulous since birth, or at least never firmly closed. In congenital cases, the hernia has, it is said, been strangulated by the application of the ligature to the umbilical cord. In infancy both sexes are equally liable to this form of hernia, but in adult life it is much more common in women, owing to the influence of pregnancy in distending and stretching the walls of the female abdomen. The sac of an umbilical hernia is always of the *acquired* variety (see page 788).

Symptoms.—In *infancy*, the hernia appears as a smooth, tense, rounded tumor, varying in size from that of a marble to that of a small orange, easily reducible, and reappearing spontaneously when the child struggles or cries. In *adult life*, the hernia often attains a very large size, is irregular in shape, and, in parts at least, doughy to the touch; it usually contains both bowel and omentum, the latter being often indurated, hypertrophied, and adherent to the sac. The hernial tumor varies in shape in different cases, but most commonly tends to hang downwards in front of the abdomen; in a remarkable case which was under my care some years ago, the tumor, when the patient was in a sitting posture, rested on the chair between her thighs. The coverings of an umbilical hernia are in most cases very thin (consisting merely of skin, fascia, and sac), and are often closely connected together. The fascia sometimes presents perforations, through which a knuckle of intestine may protrude and become strangulated. Umbilical hernia in the adult is usually irreducible, or at least not completely reducible, often becomes incarcerated, and is not rarely subject to strangulation, this accident being comparatiqely infrequent in the case of children. In some instances, *double* and even *triple* umbilical herniæ have been observed in the same individual.

Treatment.—In infants, it is usually possible to effect a cure by the use, for some months, of a compress of cork or metal, held in place by means of a suitable bandage; or, as suggested by Archambault, by the use of a plug of wax, moulded to fit the umbilicus; or, which I prefer, by the simple application of a couple of broad strips of adhesive plaster, as advised by Fergusson. The strips should be renewed from time to time as they become detached by washing. If the umbilical aperture be very large, and particularly in the case of adults (if the hernia is reducible), the *ring pad* devised by J. Wood may be advantageously employed. For *irreducible* umbilical hernia, a concave pad or bag-truss, held in place by an elastic bandage, will afford the best means of retention.

Radical Cure.—Various operations for the radical cure of umbilical hernia have been suggested and practised by Desault, Barwell, Heath, Lee, and other surgeons, the method which has attained most favor being probably that recommended by J. Wood, of London. This operation consists in approximating subcutaneously the tendinous margins of the aperture through which the protrusion has occurred, by means of pins bent at a right angle, which are introduced in opposite directions and then twisted together, or by means of two or more wire sutures introduced with a curved needle, and secured over a superimposed roll of lint. The operation is more likely to succeed in children than in adults, but, even in them, is believed by Mr. Wood to be of service, if not in obliterating, at least in diminishing the size of the hernial aperture, and thus facilitating subsequent retention with a truss.

Herniotomy.—It is very important, in the operation for strangulated umbilical hernia, to relieve the constriction without opening the sac, particularly if this be of large size—its implication in the wound being, under these circumstances, apt to be followed by a fatal result; hence, as the coverings of the hernia are commonly very thin, the surgeon should proceed with great caution in their division. The hernia being drawn down and thus made tense, an incision two or three inches long is to be made over the neck of the tumor at the upper part, and usually in the median line; the skin and fascia being divided, the finger-nail or director is slipped under the margin of the ring, which is then nicked in an upward direction. If the symptoms of strangulation persist, the hernial sac must be opened, and any internal source of constriction divided. The omentum, if closely adherent to the inner surface of the sac (as is often the case), should be left undisturbed, the gut being carefully returned, and the wound closed with sutures. The after-treatment consists in the application of a broad compress and bandage, and (if the sac have been opened) in the adoption of means to combat the peritonitis which may be expected to follow.

Fergusson advises, instead of the median incision above described, one at the side of the tumor's neck, as in Gay's method of operating for femoral hernia (see page 827). Demarquay also recommends a small lateral incision, on the left side of the sac, but forbids any subsequent attempt at reduction, believing it safer to leave the parts *in sitû*, and to rely solely upon the division of the neck of the sac to relieve the strangulation.

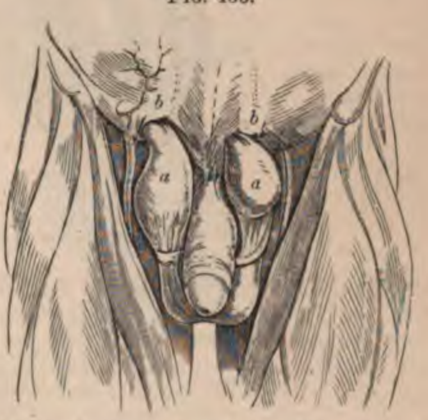
Lumbar Hernia.

In this very rare form of hernia, which appears to have been first described by Petit, in 1783, the protrusion occurs in the loin, between the crest of the ilium and the last rib. In 9 of 29 cases collected by Braun, of Heidelberg, the hernia is said to have been of traumatic origin. Two were cases of double hernia, 12 occupied the left, and 7 the right, side, while the side affected in 8 cases was not noted. Herniotomy was required in but one case (Ravaton's), in which it was successful. Additional cases of lumbar hernia have been recently recorded by Gosselin and Currier.

Inguinal Hernia.

This is the most common variety of rupture, inguinal constituting about two-thirds of the whole number of herniæ observed in both sexes. In *oblique* inguinal hernia, the protruding viscera pass through both the internal and external abdominal rings, traversing thus the whole length of the inguinal canal; in *direct* inguinal hernia, the viscera pass only through the external abdominal ring. The *oblique* variety is sometimes called *external*, because in it the neck of the hernial sac is placed to the *outer* side of the internal epigastric artery, the *direct* inguinal hernia receiving the name of *internal*, because in it the neck of the sac is to the *inner* side of the same vessel. An oblique inguinal hernia, in which the protrusion is still within the limits of the inguinal canal, is called a *bubonocele*, or an *incomplete* or *interstitial* hernia; while one in which the protrusion has passed the external ring is called a *complete* hernia, and when it occupies the scrotum, an *oscheocele*, or *scrotal* hernia.

Fig. 435.



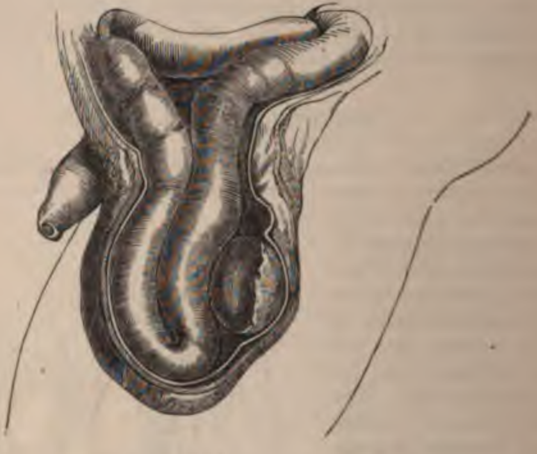
Inguinal hernia: on the right side oblique, on the left direct. *a*. The hernial sac. *b*. The epigastric artery.

I. Oblique Inguinal Hernia in the Male.

Of this we may recognize five varieties, three of which are *suddenly* developed, as the result, usually, of violent exertion, and in which a congenital defect allows the production of the hernia, while the other two are *gradually* developed. The distinction is of importance, as the former offer a better prospect of radical cure, while, at the same time, if strangulated, they are less apt to yield to the taxis than the latter.

1. Hernia into the Vaginal Process of the Peritoneum.—This is the variety ordinarily spoken of as *congenital*. As a matter of fact, however, the hernia, though most common in infancy, is occasionally not developed until late in life—it being not the disease, but the anatomical peculiarity which allows its occurrence, that is congenital. The vaginal process of peritoneum remaining patulous (pp. 787, 788), the hernia (which is suddenly developed) descends at once into the scrotum, where it lies in contact with and surrounds the testicle. In some cases, however, the hernia may descend into a patulous vaginal process, while the testis itself is retained in or immediately outside of the inguinal canal, or even within the abdominal cavity; in the former instances the hernia would, but in the latter instance would not, be in contact with the gland. The sac, in this variety of hernia, is the vaginal process itself, its mouth corresponding with the position of the internal abdominal ring, and its neck occupying the inguinal canal, which is not shortened by the approximation of the internal and external rings, as in the ordinary oblique inguinal hernia of slow formation. A sub-variety of the hernia into the vaginal process is the *hour-glass-shaped* hernia, in which a constriction or narrowing of the hernial sac (vaginal process) exists at some point between the position of the testis and that of the external abdominal ring.

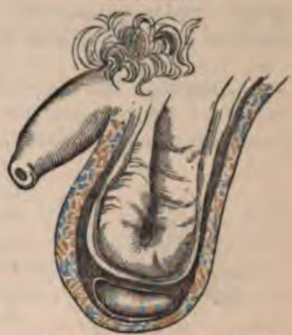
Fig. 436.



Hernia into vaginal process of peritoneum. (Pirrie.)

2. Hernia into the Funicular Portion of the Vaginal Process.—This variety of hernia (which is sometimes called "infantile," in contradistinction to the last-mentioned, or so-called "congenital" hernia), is of frequent occurrence. It is suddenly developed, and, though common in infancy, often does not make its appearance until adult life. The sac is the funicular portion of the vaginal process of peritoneum (pp. 787, 788), and the hernia, when it reaches the scrotum, lies above and separate from the testis, which is inclosed in its own proper tunic. I have shown, diagrammatically, the structure of this form of hernia in Fig. 437.

FIG. 437.

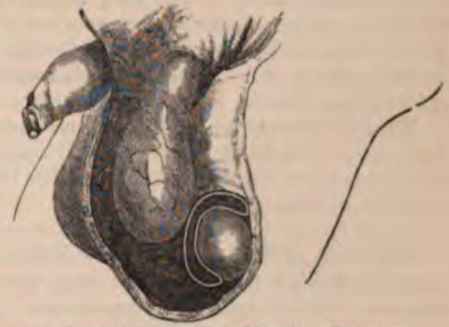


Hernia into funicular portion of vaginal process.

3. Inguino-Crural Hernia.—This is the name proposed by Holthouse for cases of suddenly developed oblique inguinal hernia, in which, owing to the non-descent of the testicle, or to other causes, the hernia, instead of passing down into the scrotum (or labium, in the case of a woman), protrudes outwards along the folds of the groin, presenting somewhat the appearance of a femoral hernia.[1] Similar to these are the cases in which prolongations of the hernial sac (vaginal process) extend in various directions *within* the abdominal walls, constituting the *inter-parietal* or *inter-muscular herniæ* of English authors, the "*hernies en bissac*" of French surgeons, and the *inguino-properitoneal* hernia of Kronlein, of Berlin, who has collected 23 cases of the kind, only one having been recognized during the life of the patient.[2]

4. Inguino-Scrotal Hernia of Slow Formation.—This is the common form of oblique inguinal hernia in persons past the middle period of life; the hernia "points" at the internal abdominal ring, forming a small circumscribed swelling, which is most prominent when the patient is erect, and which transmits an impulse when he coughs. As the hernia descends through the inguinal canal, it pushes before it the parietal layer of peritoneum, thus forming its own sac by a process of gradual distension. In this situation, it forms a somewhat elongated tumor (*Bubonocele*), lying parallel to the line of Poupart's ligament, and usually in front of the spermatic cord. When the hernia makes its appearance at the external abdominal ring, it forms a tumor of a somewhat globular shape, which, however, becomes more or less pyriform as the protrusion descends into the scrotum. Scrotal herniæ often attain an

FIG. 438.



Common inguino-scrotal hernia. (PIRRIE.)

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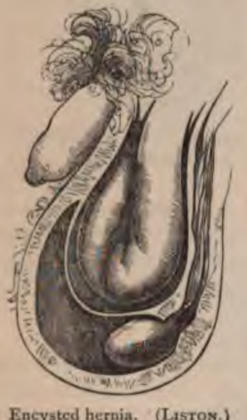
[1] See a case reported by Prof. Parker, of New York, in Am. Med. Times, Sept. 1862, and Am. Journal of Med. Sciences, Oct. 1862, p. 568.

[2] In 22 of the 23 cases the patients were of the male sex; in 15, the hernia was originally of the so-called "congenital" variety; and in 9 cases it was complicated by the presence of an undescended testicle. The affection was found 13 times on the right, and 7 times on the left side, the side in the other 3 cases not being mentioned.

enormous size, hanging perhaps as low as the knee; in such cases the hernia is commonly irreducible. In the descent of the hernia, the internal and external rings are approximated, thus shortening the inguinal canal, through which, when the hernia is reduced, the finger may be readily passed (invaginating the coverings of the hernia) within the abdominal cavity. This is not usually practicable in the suddenly developed herniæ, in which the inguinal canal maintains its normal length.

5. Encysted Hernia.—This is the "encysted hernia of the tunica vaginalis" of Cooper, and the "infantile hernia" of Hey, of Leeds. It is a hernia of slow formation, and is therefore to be distinguished from the ordinary "infantile hernia" into the funicular portion of the vaginal process. The peculiarity of this form of hernia consists in the *persistence of the testicular orifice of the funicular portion of the vaginal process of peritoneum, the ventral orifice being closed* (p. 787); as a consequence of this congenital defect, the *tunica vaginalis testis* extends up to the external abdominal ring, and the hernia, forming its own sac from the parietal peritoneum, protrudes into the tunica vaginalis, which is therefore first cut into when an operation is required in a case of this kind. This variety of hernia is very rare, and is seldom recognized before the parts are exposed in herniotomy.

Fig. 439.



Encysted hernia. (Liston.)

Coverings of Oblique Inguinal Hernia.—These are (1) the skin, (2) the superficial fascia, (3) the external spermatic or intercolumnar fascia, (4) the cremasteric fascia, containing fibres derived from the internal oblique muscle, (5) the fascia propria, internal spermatic, or infundibuliform fascia, corresponding to the fascia transversalis, and (6) the sac, which may consist of a dilatation of the parietal peritoneum, or of part or all of the vaginal process. In the *encysted hernia* there is apparently a double sac, the true sac being surrounded by both layers of the tunica vaginalis testis; hence, in laying open the sac of an encysted hernia, *three* layers of serous membrane are divided.

Though the six coverings above mentioned are properly described by systematic writers, it is seldom in practice that they can be individually recognized, the third, fourth, and fifth being commonly blended together so as to be indistinguishable.

Relations of Oblique Inguinal Hernia.—The *spermatic cord* is almost invariably *behind* the hernia, its component parts being commonly together, but occasionally separated; more rarely the various structures of the cord may be spread out *in front* of the hernia. The position of the *testicle* corresponds with that of the cord, lying *below* and *behind* the hernia, or very rarely in front of it; the hernia and testis are in contact in the so-called *congenital* hernia (into the *vaginal process*) and in the *inguino-crural* variety, but in all others are separate. The *epigastric artery* lies to the *inner* side of and behind the neck of the hernia; it is, in inguino-scrotal herniæ of long standing, somewhat deflected from its normal oblique course, by the shortening of the inguinal canal, and then passes upwards and slightly inwards beneath the outer border of the rectus abdominis muscle.

II. Oblique Inguinal Hernia in the Female.

Of this we may recognize two varieties—one of sudden development, in which the hernia descends into the *canal of Nuck*, this variety corresponding with the hernia into the vaginal process of the male ("congenital" hernia), and one of gradual development, the *inguino-labial*, corresponding to the ordinary inguino-scrotal hernia of the male. When, in a case of hernia into the canal of Nuck, the protrusion extends obliquely outwards in the line of Poupart's ligament, the hernia may be properly called *inguino-crural*. The coverings and relations of these herniæ are the same as in the corresponding herniæ of the male, substituting merely round ligament for spermatic cord, and labium pudendi for scrotum.

Hernia into the Canal of Nuck is the commonest form of hernia met with in girls, and, with the exception of umbilical hernia, is the only form which occurs in female infants. It is in these cases, according to Kingdon, not unusual to find the ovary in contact with the hernia.

Inguino-Labial Hernia, contrary to the commonly received notion, is almost as frequent in women as femoral hernia. The symptoms are very much those of the inguino-scrotal hernia of the male, except that the tumor rarely attains as large a size, and is less pyriform in shape. The neck of the hernia is, besides, larger and narrower than in the corresponding hernia in the male.

III. Direct Inguinal Hernia.

This occurs in both sexes. The direct inguinal hernia is always gradually developed, except in the contingency of a traumatic laceration of the structures immediately behind the external abdominal ring, when a hernia may suddenly protrude. The hernia "points" behind the external abdominal ring, and escapes through the space known as Hesselbach's triangle, usually pushing before itself, or separating the fibres of, the conjoined tendon, but occasionally passing to the outer side of the latter. Leaving the external ring, the hernia reaches the upper portion of the scrotum, where it forms a tumor which is more globular in form than that of an oblique inguinal hernia. The long axis of the sac, moreover, is parallel to the median line of the body, and its neck close to the outer border of the rectus muscle—not curving outwards in the line of Poupart's ligament, as in the case of a hernia which has traversed the entire length of the inguinal canal.

Coverings of Direct Inguinal Hernia.—These vary according to the particular part of the triangle of Hesselbach through which the hernia protrudes. In the common form of direct inguinal hernia the coverings are (1) skin, (2) superficial fascia, (3) intercolumnar fascia, (4) fibres of the conjoined tendon, (5) transversalis fascia, and (6) the sac. In the comparatively rare instances in which the protrusion occurs to the outer side of the conjoined tendon, the latter does not furnish any part of the investments of the hernia, which then carries with it a portion of the cremasteric fascia, as in the case of the oblique inguinal hernia.

Relations.—The *spermatic cord* (or *round ligament*) passes almost invariably along the *outer and posterior* side[1] of the hernial sac, while the *epigastric*

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[1] Todd met with a case in which the cord passed in front of the sac, and B. Wills Richardson with one in which the cord passed on its inner side.

artery also courses along the *outer* side of the sac, arching above the neck of the latter to reach the sheath of the rectus muscle.

Anomalous Inguinal Herniæ.—It occasionally, though very rarely, happens that an inguinal hernia escapes, not through the external abdominal ring, but through an abnormal opening in the aponeurosis of the external oblique muscle, close to the ring. In such a case the spermatic cord would not be in direct contact with the hernia.

DIAGNOSIS OF INGUINAL HERNIA.

From *Femoral Hernia*, an inguinal hernia may be distinguished by observing (1) that it invariably protrudes *above the line of Poupart's ligament*, and (2) that the external abdominal ring (through which an inguinal hernia escapes) lies to the *inner side of the pubic spine*. Hence, if the neck of the sac be found *outside* of this prominence, it may be inferred that the hernia is not inguinal. The *Differential Diagnosis* between the various forms of inguinal hernia may usually be made by investigating the history of the case, and by attention to the symptoms which have been described as characterizing the several varieties of the affection. In other instances, however, and particularly in cases of strangulation, the surgeon may be unable to say positively even whether the hernia is oblique or direct.

Inguinal Hernia which has not descended into the Scrotum is to be distinguished from *abscess*, *hydrocele* or *hæmatocele of the cord*, *tumor of the cord*, *adenitis*, and *undescended testis*.

(1.) *Abscess* arising within the pelvis and pointing in the course of the inguinal canal is reducible, and may transmit an impulse when the patient coughs, but can be distinguished from hernia by its fluctuating character, and by the absence of gurgling in reduction.

(2.) *Hydrocele of the Cord* may be distinguished by its elastic, semi-fluctuating character, its translucency if low down, the impossibility of complete reduction within the abdominal cavity, and the absence of gurgling. The same signs may, in the female, serve for the diagnosis, from hernia, of a serous cyst, which sometimes occupies the canal of Nuck (*Hydrocele of the Round Ligament*).

(3.) *Hæmatocele of the Cord* may be recognized by the existence of fluctuation and ecchymosis, by the impossibility of complete reduction, and by the absence of gurgling.

(4.) *Tumors of the Cord* have a well-defined outline, transmit no impulse on coughing, and are irreducible.

(5.) *Enlarged Lymphatic Glands* are commonly situated *below* Poupart's ligament; but when a single gland is above, and inflamed, the case may be mistaken for one of strangulated hernia, the diagnosis perhaps being only cleared up by an exploratory incision. In a case of supposed hernia which came some years ago under my care, I found the inguinal tumor to be glandular, and to be dependent upon cancer of the vagina which had not been detected.

(6.) *An Undescended Testis* occupying the inguinal canal may be distinguished from hernia by the impossibility of reduction, the absence of gurgling, the peculiar sickening sensation caused by pressure, and the fact that there is no testicle in the scrotum of that side. The difficulty is greater when the undescended testis is inflamed, but here (unless a strangulated hernia coexist) the diagnosis may be made by attention to the points already mentioned, and by noting the character of the vomiting, which in the case of an inflamed testis is not persistent, and never stercoraceous.

Scrotal Hernia is to be distinguished from *hydrocele of the tunica vaginalis, hæmatocele, varicocele,* and *tumors of the testis.*

(1.) *Hydrocele* is to be distinguished by its translucency, its tense and semi-elastic character, its irreducibility, and the absence of impulse on coughing; it begins at the *bottom* of the scrotum, instead of at the *top*, as is the case with hernia, and is distinctly circumscribed, the cord being readily perceptible above it. If a hydrocele of the cord coexist, the diagnosis is more difficult. *Congenital hydrocele,* in which the communication between the tunica vaginalis and peritoneum persists, though reducible by pressure, may be distinguished by the absence of gurgling, and by the gradual manner in which the tumor reappears when the pressure is removed. *Hernia and hydrocele may coexist,* in which case the hydrocele is usually in front, and each tumor presents its own characteristic peculiarities.

(2.) *Hæmatocele* may be distinguished by its history (of traumatic origin), its irreducibility, the absence of impulse and gurgling, and the distinctness with which the cord may be felt above.

(3.) *Varicocele* may be distinguished from hernia by making the patient lie down and by elevating the scrotum, when the tumor, if a varicocele, will disappear slowly and without gurgling; if now the surgeon press *gently* on the external abdominal ring, and direct the patient to rise, the tumor, if a varicocele, will be slowly reproduced, beginning at the bottom of the scrotum, but if a hernia, will not reappear; if, on the other hand, *moderately firm* pressure be made upon the cord *below* the external ring, so as to take off the weight of the superincumbent column of blood, and thus prevent distension of the spermatic veins, the tumor, if a varicocele, will *not* be reproduced, whereas a hernia will slip down alongside of the finger.

(4.) *Tumors of the Testis* may be distinguished by their rounded shape and solid feel, by the absence of impulse or gurgling, by their irreducibility, and by the non-implication of the cord and inguinal canal.

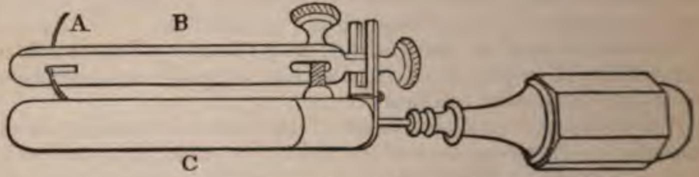
Treatment of Inguinal Hernia.

The Palliative Treatment of *oblique* inguinal hernia consists, when the rupture is reducible, in the application of a truss, the pad of which should be of an elongated shape, and should press upon the whole extent of the inguinal canal and upon the *internal* abdominal ring. In applying a truss for hernia into the vaginal process, in a child, great care must be taken not to press injuriously upon the testis, if this have not fully descended. For *direct* inguinal hernia, a truss is required which shall support the abdominal parietes behind the external abdominal ring; a good instrument for the purpose is that with an "ovoid-ring pad," as employed by Mr. John Wood. For *irreducible* inguinal hernia of either form, a hollow pad, or suspensory or bag-truss is to be applied.

Radical Cure.—Of the numerous ingenious operations which have been devised for the radical treatment of inguinal hernia, I shall describe but five, viz.: 1, Wutzer's; 2, Syme's and Fayrer's (which are essentially the same); 3, Agnew's; 4, Buchanan's; and 5, J. Wood's. Modifications of Wood's method have been devised by Mr. Spanton, of Hanley, by Prof. Annandale, and by Dr. Greensville Dowell, of Texas, the latter of whom applies subcutaneous sutures by means of what he calls a "shuttle-needle," and reports 60 at least temporary successes in a total of 68 operations. Mr. Spanton pins together the sides of the inguinal canal with an instrument resembling a corkscrew.

1. *Wutzer's Method* consists in invaginating a plug of scrotum in the inguinal canal, and endeavoring to fix it there by exciting inflammation in the neck of the sac. The patient is placed in a supine posture, the rectum and bladder being empty, the affected part carefully shaved, and the hernia thoroughly reduced. Invagination is effected by pushing up a cone of the scrotal tissues with the left forefinger, which is introduced within the internal ring; an oiled, hollow, boxwood cylinder (Fig. 440, C) is carefully introduced as the finger is withdrawn, so as to maintain invagination; along the inner surface of this cylinder, a flexible needle (A), gilt to prevent corrosion, is passed by means of a movable handle, and thrust through the scrotum, hernial sac, anterior wall of the inguinal canal, and tissues of the groin, the operation being completed by the application externally of a concave boxwood case or roof (B), the curve of which corresponds to that of the cylinder, and which passes over the point of the needle and is held in place by means of a screw at the other end. The apparatus is kept in place for about a week, the invaginated plug being subsequently supported by a roll of lint and a spica bandage; the patient is kept in bed about three weeks, and should wear a light truss for several months afterwards.

FIG. 440.



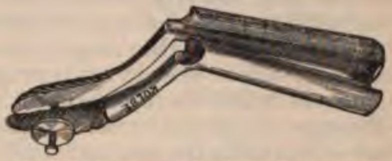
Wutzer's apparatus for radical cure of hernia.

2. *Syme's Method* is a modification of the above, and is thus described by its author: "Instead of a complicated machine for distending the invaginated integument, I employed a piece of bougie or gutta-percha, to one end of which was attached a strong double thread. The plug thus prepared and smeared with cantharides ointment, was drawn into its place by the threads, which, by means of a curved needle guided on the finger fairly within the ring, were passed, at the distance of rather more than an inch from each other, through all the textures to the surface, where they were tied firmly together on a piece of bougie, to prevent undue pressure on the skin." The plug is left in position ten days, and the patient kept in bed a fortnight longer. *Prof. Fayrer's Method* differs from Syme's, merely in the substitution of an oiled wooden plug for that of gutta-percha; in the fact that the ligatures (which are of silk), though introduced at different points, are brought out through the *same* aperture in the groin, where they are tied over a piece of wood or ivory; and in the withdrawal of the plug in from two to six days. Thirty-eight cases operated on in this way by Fayrer gave twenty-four cures (the permanence of which was, however, not ascertained), while twenty-five cases operated on by Wutzer's plan gave the smaller proportion of fourteen cures.

3. *Agnew's Method.*—For this operation, a special instrument is required, which resembles a bivalve speculum, and consists of two semi-cylindrical

blades with handles, with two grooves on the inner or concave surface of each blade, and a rod and screw to regulate the degree to which the blades are separated. An incision 2½ inches long is made over the scrotum, passing downwards from a point three-fourths of an inch below the external abdominal ring; the subjacent tissues are separated from the skin of the scrotum by the finger, introduced through the incision, and then invaginated, the "speculum" being made to replace the finger, as in Wutzer's operation. The blades of the instrument are then separated, and a long-handled needle, armed with a silver wire, passed along one of the grooves of the lower blade, thrust through the intervening structures, and brought out on the surface of the body over the internal ring; the needle is then unthreaded and withdrawn, rethreaded with the other end of the wire, and passed along the second groove, to be brought out at nearly the same point as before. Both ends of the wire are then drawn tight and firmly twisted together. A short needle is next armed with silk or wire, and passed across the inguinal canal between the blades of the speculum at three points, near the summit, at the middle, and just above the external ring; these sutures are tied over a roll of lint, the speculum removed, and the operation completed by the application of a compress and bandage. The sutures are removed on the eighth day, and the patient is kept in bed, in all, for about three weeks, and subsequently furnished with a light truss. "With reference to my own operation," says Prof. Agnew, "the success obtained has not been sufficiently uniform to justify me in speaking of it in any other way than with distrust." An operation similar in principle, though somewhat differing in details from Prof. Agnew's, is employed by Mr. Croly, of Dublin.

FIG. 441.



Agnew's instrument for the radical cure of hernia.

4. *Prof. Buchanan*, of Glasgow, in cases of congenital hernia, in children, employs an operation somewhat resembling that just described, except that he divides the sac transversely, invaginating the upper portion, and turning the lower part downwards to form a tunica vaginalis.

5. *Wood's Method.*—The most important feature of Mr. Wood's various operations consists, as has been already mentioned, in applying sutures in such a way as to effect compression and closure of the tendinous sides of the hernial canal in its whole length. The instruments required are, (1) a strongly-curved needle, eyed near the point, and mounted in a firm handle; (2) a knife somewhat resembling a tenotome; (3) a strong, hempen thread, or silvered copper wire; and (4) a compress, which, if the thread be used, is to be made of boxwood, glass, or porcelain.

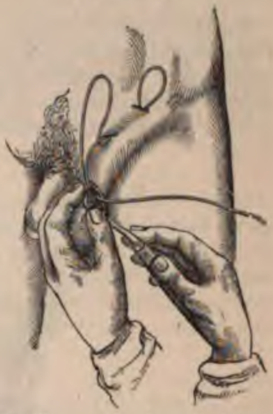
(1.) *Operation with Thread.*—The patient being anæsthetized, and the rupture thoroughly reduced, a small scrotal incision is made over or below the fundus of the hernial sac, and the skin and fascia separated over an area two or more inches in diameter, by means of the knife introduced flatwise. The knees of the patient are then brought together, and elevated so as to relax the structures of the groin, and the detached fascia invaginated with the forefinger, which is pushed well up into the inguinal canal, with the nail directed backwards. The finger being hooked forwards, so as to raise the lower border of the internal oblique muscle, and with it the conjoined tendon, the unarmed needle, well oiled, is passed up on the pubic side of the finger, pushed deeply through the tendon at its most salient part, made to traverse the internal pillar of the superficial ring obliquely upwards and inwards, and finally brought through the skin, which is first drawn inwards and upwards as much as its deep attachments will allow. One end of the thread is then passed through the eye of the needle, which is quickly withdrawn, leaving the other end of the thread in the puncture. The finger is next placed behind the external pillar of the superficial ring, close to Poupart's ligament, opposite the internal hernial opening, in the groove between the spermatic cord and the ligament. The finger is again raised, stretching the aponeurosis, and the needle (which is now armed) passed between the point of the finger and Poupart's ligament, pushed through the latter, and brought out at the same opening as before; a loop of the thread is this time left in the puncture, and the needle carrying the free end again withdrawn. The finger is now placed on the inner side of the spermatic cord, just above the pubic spine, and pressed firmly upon the conjoined tendon, pushing this backwards and the cord outwards, so as to feel the border of the rectus tendon. Into the tendinous layer of the *triangular aponeurosis* covering this part of the rectus, the needle is then deeply thrust, turned obliquely towards the surface, and a third time brought out through the original puncture, which now contains both ends of the thread and an intermediate loop; two portions of thread thus cross the hernial canal, invaginated fascia, and sac, closely embracing but not including the spermatic cord, and joining together the front and back walls of the canal. The compress is placed obliquely over the canal, the free ends of thread and the loop crossed and firmly drawn in opposite directions, and the whole then secured by passing one end of the thread through the loop and tying it back to the other end in a "bow-knot." The operation is completed by the application of pads of lint and a spica bandage. The knot is untied and the compress removed from the third to the seventh day, the threads being allowed to remain as setons as long as may be deemed necessary.

(2.) *Operation with Wire.*—The preliminary steps are the same as when the thread is used, but in passing the needle for the second time it is unarmed, and withdrawn armed with the other end of the wire, thus leaving a loop above and bringing both free extremities out at the scrotal incision below: the hernial sac and the fascia covering it opposite the scrotal aperture are then pinched up with the finger and thumb, and the cord slipped back as in the operation for varicocele, when the needle is passed (entering and emerging through the scrotal wound) from without inwards and a little upwards, immediately in front of the spermatic cord; it is now armed with one of the ends of wire (either will answer the purpose) and withdrawn; the next step is to straighten and draw down the ends of wire until the loop is near the skin, where it is held while the ends are twisted together with three or four turns, the inclosed sac and fascia being thus twisted and held between the ends of wire. The loop is now drawn upwards, so as to effect complete invagination of the twisted sac and scrotal fascia, and in its turn twisted down into the groin puncture; the ends of the wire are then cut off about three inches from the surface and bent into a hook which is carried upwards to meet the loop, both being locked together over a compress of lint, and the whole covered with a spica bandage. The wire may be untwisted about the eighth or tenth day, and removed about the fourteenth.

(3.) *Operation with Pins.*—For small ruptures in children, particularly for ruptures into the vaginal process, Mr. Wood resorts to the use of pins bent at a right angle; these are passed in opposite directions one through the conjoined tendon and internal pillar, and the other through the external pillar of the ring, the hernial sac being transfixed by both pins, which are then twisted together. The pins are withdrawn from the second to the tenth day.

Mr. Wood's statistics of his operation up to 1873, were given on page 794; a later report by the same surgeon shows but 119 ascertained recoveries out of 310 cases; and 30 operations by one or other of his methods, recorded in the Reports of the Boston City Hospital, gave only 8 recoveries, 3 "fair results," 2 deaths, and 17 failures.

FIG. 442.

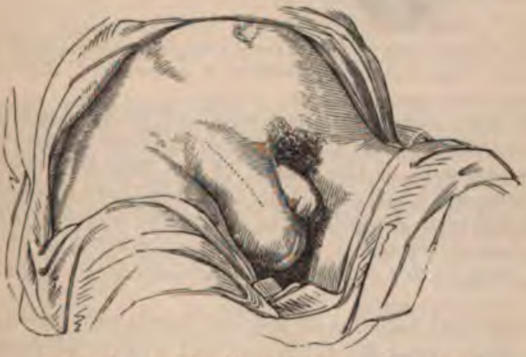


Wood's operation for radical cure of hernia.

Taxis for Inguinal Hernia.—In employing the taxis, in a case of inguinal hernia, the pressure must be applied strictly in the direction of the inguinal canal, *i. e.*, obliquely upwards and outwards. It must, however, be remembered that in a case of inguino-scrotal hernia of long-standing, the direction of the canal itself becomes changed, by the approximation of the abdominal rings.

Herniotomy.—An incision of from two to four inches in length is made in the direction of the long axis of the tumor (Fig. 443), so that the position of the external ring will be a little above the middle of the wound; the various coverings of the hernia are then carefully divided, until the director or tip of the finger can be insinuated beneath the edge of the ring, when, if this be found to exercise any constriction, it is to be incised in an upward direction, in a line parallel to the linea alba. The taxis may be then gently employed, when it will occasionally happen that reduction can be effected without further trouble, but if such is not the case, the internal ring is to be explored and similarly dealt with: in the majority of instances, however, the stricture is in the neck of the sac itself, and an opening must then be made of sufficient size to allow the introduction of the finger, which is passed up to the seat of obstruction, a hernia-knife following and nicking the stricture in the way described at page 807. It is a well-established rule that the incision in this part of the operation should be made directly upwards, in a line parallel to the linea alba, so that whether the rupture be of the oblique or direct variety (and this cannot always be determined beforehand), the epigastric artery may escape injury.

FIG. 443.



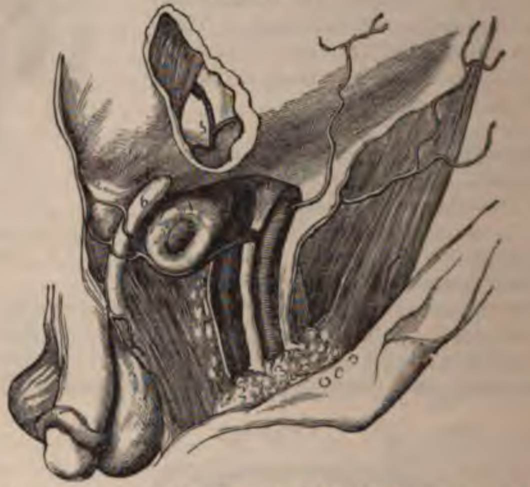
Incision for strangulated inguinal hernia. (FERGUSSON.)

FEMORAL OR CRURAL HERNIA.

(*Merocele.*)

In this form of hernia, which is more common in women than in men (in the proportion, according to Croft, of nearly five to one), the protrusion takes place beneath Poupart's ligament, and almost invariably to the inner side of the femoral vein. Descending through the femoral ring, the hernia pushes before it the parietal layer of peritoneum (thus forming its own sac),

FIG. 444.



1, Femoral hernia ; 2, femoral vein ; 3, femoral artery, giving off, 4, common trunk of epigastric and obturator arteries, and 5, epigastric artery ; 6, spermatic cord. (ERICHSEN.)

with the dense layer of areolar tissue which normally closes the ring and is known as the *septum crurale;* passing downwards along the crural canal, in the inner compartment of the sheath of the femoral vessels, the hernia changes its course upon arriving at the saphenous opening, and, turning forwards, pushes before it the cribriform fascia, and curves upwards on to the falciform process of the fascia lata and lower portion of the external oblique tendon, lying at this point beneath the superficial fascia and skin.

Varieties.—Several varieties of femoral hernia are described by systematic writers. Thus, when the rupture is still within the crural canal it is called *incomplete*, being *complete* when it has passed the saphenous opening. Another division is founded upon the relations of the sac to the internal epigastric and obliterated umbilical arteries, the common form, in which the mouth of the sac lies between these vessels, being called *middle crural* hernia, and the rare varieties in which it lies to the outer side of the epigastric, or to the inner side of the umbilical artery, being called, respectively, *external* and *internal* crural hernia. LeGendre has described four rare varieties, to which Birkett has added a fifth: these are, (1) the *pectineal crural*, or hernia of Cloquet, in which, after passing the femoral ring, the hernia turns within and behind the femoral vessels, resting on the pectineus muscle; (2) the *hernia through Gimbernat's ligament*, or hernia of Laugier, the anatomical peculiarities of which are sufficiently expressed by its name;

(3) the *hernia with a diverticulum through the cribriform fascia,* or hernia of Hesselbach, in which the hernia protrudes through several openings in the cribriform fascia, getting thus a lobulated appearance; (4) the *hernia with diverticulum through the superficial fascia,* or hernia of Cooper, which, *mutatis mutandis,* is similar to that last mentioned; and (5) the *hernia external to the femoral vessels,* or hernia of Partridge. Tessier has recorded a case, to which Kronlein gives the name of *cruro-properitoneal hernia,* in which an additional sac existed between the peritoneum and abdominal wall, in the cellular tissue of the pelvis and side of the bladder. A similar case has been successfully submitted to an operation for radical cure by C. J. Rossander.

Coverings.—The coverings of an ordinary *complete* femoral hernia are (1) skin, (2) superficial fascia, (3) cribriform fascia, (4) crural sheath, (5) septum crurale, and (6) sac. The septum crurale and adjacent portion of the crural sheath are commonly matted together, constituting the *fascia propria* of Cooper. The coverings of an *incomplete* femoral hernia are the same, substituting the falciform process of the fascia lata for the cribriform fascia.

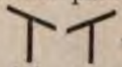
Relations.—The *femoral vein* lies close to the outer side of the hernia, and separated from it merely by a septum of the crural sheath, the *epigastric artery* is above and to its outer side, while the *spermatic cord* or *round ligament* passes almost immediately above it on the inner side. The *obturator artery,* when, as not unfrequently happens, it arises from the external iliac, common femoral, or epigastric, instead of from the internal iliac artery (as in the normal condition), usually descends on the outer side of the crural ring to reach the obturator foramen, but occasionally skirts along the free border of Gimbernat's ligament, when it would almost completely encircle the neck of the hernial sac. In the rare cases in which the hernia escapes externally to the femoral vessels, the *circumflex ilii* artery would lie to the outer side of the sac.

Diagnosis.—Femoral hernia seldom attains a large size, appearing usually as a firm, tense, rounded tumor, on the inner side of the femoral vessels, and invariably originating *below* Poupart's ligament—though it frequently passes *above* that structure, as it curves upwards after emerging from the saphenous opening. When of large size, the appearances are somewhat different, the tumor then being often soft and doughy, even though strangulated. The diagnosis of crural from *inguinal hernia,* can always be made by observing the relations of the neck of the hernia to Poupart's ligament and the spine of the pubis, as pointed out at page 818. *Obturator hernia* can be distinguished by noting its deep situation and the freedom of the femoral ring. *Enlarged lymphatic glands* may be mistaken for crural hernia, but can usually be distinguished by observing that there is more than one tumor, and that there is no impulse on coughing, and by attention to the history and progress of the case. As, however, a strangulated femoral hernia may exist behind an enlarged gland, in any case of doubt an exploratory incision should be made. The same course may be necessary if symptoms of strangulation occur in a case in which a *fatty or cystic growth* occupies the region of the femoral ring. For the diagnosis of crural hernia from *psoas abscess,* see page 661. A *dilated and varicose condition of the saphena vein* may be distinguished by the absence of gurgling on reduction, and by the return of the tumor when the patient stands up, even though pressure be made at the crural ring.

Treatment of Femoral Hernia.—The **Palliative Treatment** consists in the application of a well-fitting truss, which, in ordinary cases, should be furnished with a small and convex pad, made to press just below Poupart's ligament and a little to the outside of the pubic spine, in the line of the crural canal. If, however, as is sometimes the case, the whole crural arch be much relaxed, a large and rather flat pad is preferable, in order to press Poupart's ligament against the body of the pubis, and thus approximate the walls of the canal. A hollow-pad or bag-truss must be employed if the hernia is irreducible.

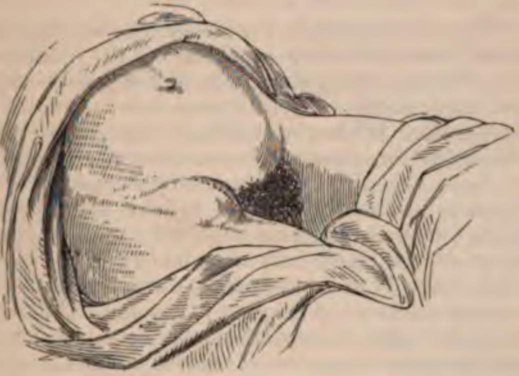
Radical Cure.—Mr. Wood has described an operation in which wire is used in the same manner as in his second method of treating inguinal hernia, and by which "that part of the tendinous crural arch which overrides the neck of the sac is drawn backwards and downwards, and becomes adherent to the pubic portion of the fascia lata." Cheever, of Boston, has recorded one case in which this plan was resorted to without any permanent benefit, but no extended statistics of the operation have, I believe, as yet been published.

Taxis.—In applying the taxis in a case of femoral hernia, the thigh of the affected side should be strongly flexed, rotated inwards, and carried well across the opposite limb, so as to relax the crural arch. Pressure is to be made in accordance with the direction of the descent of the hernia, viz., first downwards, so as to clear the falciform process, then backwards, and finally upwards in the line of the crural canal. The taxis is less likely to succeed in femoral than in inguinal hernia, and the proportion of cases requiring herniotomy is therefore greater. Moreover, there is less time for delay, as strangulation in crural rupture is commonly of the *acute* variety (see p. 801).

Herniotomy.—The external incision may vary according to the fancy of the operator, some surgeons preferring a single longitudinal incision, others one which is oblique and parallel to Poupart's ligament, while still others combine both, thus, , or make a slightly curved cut over the pubic side of the neck of the tumor, reaching one inch above and one or two below the crural arch. The superficial coverings having been divided, the condensed layer formed by the septum crurale and crural sheath (*fascia propria*) is cautiously opened, so as to expose without wounding the sac. The finger is then passed up *below* the fascia propria, and the nail, or the extremity of a grooved director, insinuated under the sharp edges of Gimbernat's ligament and the falciform process at their point of junction (Hey's ligament), the hernia-knife being then introduced and made to cut *upwards and inwards* for a space not exceeding two lines. If reduction cannot now be effected, any constricting fibres of the fascia propria which may have been left are to be carefully severed, when, if the hernia be still irreducible, the sac must be opened, and the stricture sought for and divided, with the precautions described on a previous page. It is sometimes possible to relieve the strangulation by nicking Gimbernat's and Hey's ligaments outside of the fascia propria. In the majority of instances, however, the stricture is in this structure itself, requiring it to be laid open in the manner above described. The fascia propria, when much thickened and congested, may be mistaken for the hernial sac, or for a mass of omentum. It has not, however, the arborescent arrangement of vessels which characterizes the former, and is more rounded and uniform in appearance than the latter.

The direction in which the stricture is to be divided, whether the sac be opened or not, is invariably *upwards and inwards*. An outward incision might wound the femoral vein, one upwards and outwards the epigastric artery, and one directly upwards the spermatic cord, while an inward incision would divide Gimbernat's ligament only, and therefore probably fail to relieve the constriction. The only possible risk in the incision upwards and inwards, is of wounding the obturator artery, in the rare cases in which this vessel winds around the neck of the sac (page 825). This danger may be obviated by employing a knife with a concealed blade, as advised by Corley and Hayes, or by slightly blunting the edge of the hernia-knife, which will then push the vessel before it, while it will still be sharp enough to divide the fibrous bands which impede reduction. Wyeth advises that the point of the knife should be kept firmly pressed against the pubis during this step of the operation, as, if the cutting edge does not pass beyond the ligament, the artery cannot be wounded. As already mentioned, a very limited incision is sufficient. Should the obturator artery be accidentally wounded, hemorrhage from either end must be arrested by torsion, or, if this fail, by the application of a ligature.

FIG. 445.



Incision for strangulated femoral hernia. (FERGUSSON.)

Herniotomy by Gay's Method.—An incision about an inch in length is to be made on the *inner side* of the tumor, near the neck of the sac, and the various tissues cautiously divided until a concealed bistoury can be introduced flatwise between the neck of the sac and the inner margin of the crural ring. The edge of the knife is then turned towards the pubis, when, by projecting the blade, the stricture is readily divided. The small lateral incision which is practised in this mode of operating, was highly commended by the late Sir William Fergusson, who declared that he rarely employed any other. This distinguished surgeon, however, apparently completed the operation with the ordinary hernia-knife, instead of with the *bistouri caché*, as originally advised by Gay.

OBTURATOR HERNIA.

In this rare form of hernia, which was first described by Garengeot, the protrusion takes place through the obturator foramen, forming in some cases a well-marked tumor in Scarpa's triangle, though, in other instances, not even the slightest fulness of the part has been perceptible. The affection is commoner in women than in men, and the hernial sac (which is one of gradual development) is always small, not unfrequently containing a portion only of the calibre of the bowel. Obturator hernia is occasionally complicated by the coexistence of femoral or inguinal hernia, and, in a case recorded by Hilton, the sac of an obturator hernia was found on either side of the body. The position occupied by an obturator hernia is in Scarpa's triangle, behind and somewhat to the inner side of the femoral vessels, and to the outer side of the adductor longus tendon; the hernial tumor is covered by the pectineus muscle. Zoja, an Italian surgeon, has recorded a case of obturator *cystocele.*

Diagnosis.—When the protrusion is perceptible, the case may be diagnosticated from one of femoral rupture by observing the position of the tumor in relation to the femoral artery and body of the pubis—these structures lying behind the tumor in the case of a crural, but in front of it in the case of an obturator, hernia. When no swelling is observable, the symptoms of strangulation being at the same time present, the diagnosis of obturator hernia may be made, according to Birkett, by attending to the following particulars: (1) there is often a history of colicky pains previously felt in the pelvic region, sometimes relieved with an accompanying sensation of something having slipped back into the abdomen; (2) the evidences of strangulation may have been preceded by a sudden and violent pain at the inner and upper part of the thigh; (3) cramp in the abdominal muscles, rather than pain within the abdomen, may be complained of, obviously due to reflected irritation from the cutaneous filaments of the obturator nerve; (4) pain in the course of the distribution of the obturator nerve—a very significant symptom, the value of which was first pointed out by Howship—may be induced or increased by rotating the thigh outwards, and thus putting the obturator muscle on the stretch; (5) pain may be elicited by making pressure over the external outlet of the obturator canal, comparing the effect on either side of the body; and (6) pain may be elicited by pressing on the pelvic outlet of the canal with the finger introduced into the vagina or rectum.

Treatment.—If the hernial tumor be perceptible, an attempt may be made to effect reduction by means of the taxis; but if this fail, or if there be reason to suspect the existence of strangulated obturator hernia, though no swelling can be recognized, an exploratory operation should at once be resorted to. A longitudinal incision about three inches in extent may be made, beginning a little above Poupart's ligament, and passing downwards on the inner side of the femoral vessels. The pectineus muscle being divided, and the fibres of the obturator separated with the director or handle of the knife, the sac of the hernia, if there be one, will be exposed. The taxis should now be tried again, when, if still unsuccessful, the sac should be opened, and the stricture cautiously divided in an upward direction. Birkett has collected twenty-five recorded cases of strangulated obturator hernia, in fourteen of which the nature of the affection was not discovered until after the patient's death, while in one the symptoms disappeared spontaneously without treatment. Of the ten cases recognized during life and submitted to treatment, four recovered and six died. The taxis was employed in two cases with one recovery; and herniotomy in six cases with three recoveries. In one case (Hilton's)[1] the diagnosis was not made until after the performance of laparotomy (the patient dying), and in another, in which the integuments were becoming gangrenous when the case was first seen, the patient died the day after the establishment of a fecal fistula.

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[1] A second case of laparotomy (fatal) for obturator hernia has since been recorded by Coulson.

PERINEAL HERNIA.

In this form of rupture, the protrusion occupies the perineum, and is placed usually between the rectum and prostate in the male, and between the rectum and vagina in the female, but, occasionally, on one or other side of the anus. Perineal hernia, which is more common in women than in men, is readily reducible, and may be kept within the pelvic cavity by the use of a pad and T bandage.

PUDENDAL OR LABIAL HERNIA.

In this variety, the hernia occupies one of the labia majora, descending between the vagina and the ramus of the ischium. Pudendal hernia is to be diagnosticated from *inguino-labial* and from *femoral* rupture, and from *cysts of the labium* and *of the canal of Nuck*, the so-called *hydrocele* of that part. From *inguino-labial hernia*, it may be distinguished by the parallelism of its axis with that of the vagina, by the non-implication of the inguinal canal, by its rounded rather than pyriform shape, and by its position alongside of the ramus of the ischium instead of over the body of the pubis; from *femoral hernia*, by the position of the neck of the hernial sac as regards the ramus of the ischium, this bone lying *externally* in the case of pudendal, and *internally* in the case of crural, rupture; and from *cystic growths*, by their irreducibility, their tense and resisting character, their gradual increase in size, and, in many instances, the possibility of completely isolating them with the fingers. The *treatment* consists in the introduction of a suitable pessary, or in the application of an elastic bandage. Should strangulation occur, and herniotomy be required, the stricture should be divided in an inward direction.

VAGINAL HERNIA.

The protrusion occupies either the anterior or posterior wall of the vagina, and may produce discomfort by compressing either the rectum or urethra. The *treatment* consists in the use of a suitable pessary or elastic bandage, and in the employment of the catheter, if there is any difficulty in evacuating the contents of the bladder.

ISCHIATIC OR SCIATIC HERNIA.

The hernia protrudes through the sciatic notch, usually below, but sometimes above, the pyriformis muscle, and projects beneath the gluteus maximus. The treatment consists in the application of a pad and elastic bandage; should herniotomy be required, the stricture should be divided, as recommended by Sir Astley Cooper, in a forward direction. An interesting example of this rare form of hernia has been recently reported by Crosslé, of Dublin.

CHAPTER XLII.

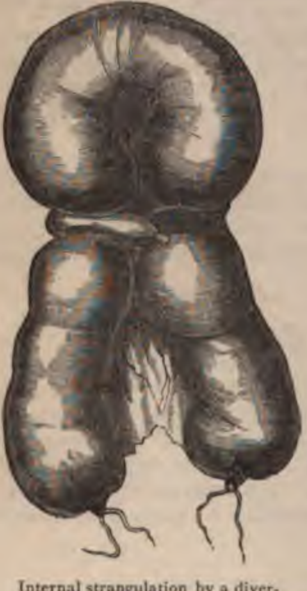
DISEASES OF INTESTINAL CANAL.

Intestinal Obstruction.

Obstruction to the passage of fecal matter along the intestinal canal may be due to various causes, some of which produce acute symptoms and often terminate life in the course of a few days, while others act comparatively slowly—the obstruction in these cases not unfrequently yielding spontaneously, and, even when proving fatal, not doing so for a considerable period; hence the customary division of cases of intestinal obstruction into two classes, the *acute* and *chronic*, a division which is convenient for purposes of study, and will, therefore, be retained, though in practice, cases will often be met with which are on the border line between the two varieties, the acute forms of obstruction sometimes, as well remarked by Pollock, subsiding into the chronic, while, on the other hand, the chronic cases may at any moment become acute.

Acute Intestinal Obstruction.—The most frequent causes of this form of obstruction are (1) *congenital malformations;* (2) the *impaction of foreign bodies,* gall-stones, etc.; (3) *invagination* or *intussusception*—the upper segment of bowel commonly slipping within the grasp of the lower, like the finger of a glove when it is taken from the hand, though occasionally the lower segment is invaginated into the upper, constituting *retrograde intussusception;* (4) *twisting* of the bowel upon itself—*volvulus*—commonly connected with abnormal elongation of the mesenteric attachment of the affected gut; and (5) *internal strangulation,* due to the binding down of the bowel by a diverticulum, or by a band of organized lymph, to the protrusion of the gut through an aperture in the mesentery or omentum, etc. Symptoms of acute obstruction may also occur in the course of *inflammatory affections* of the abdomen, such as enteritis, peritonitis, or typhlitis, or (as already mentioned) in cases of chronic obstruction, especially from *cancerous disease* of the bowel. *Spasm,* without organic change, is considered by some authors to be capable of producing acute obstruction; but though the possibility of such an event may not be denied, its occurrence must be extremely rare. F. Jordan believes that

Fig. 446.



Internal strangulation by a diverticulum. (Pirrie.)

either acute or chronic obstruction may result from fatty degeneration of the muscular wall of the bowel.[1]

Symptoms of Acute Obstruction.—These are usually well marked; the patient commonly experiences intense *pain*, often referred to a particular spot, accompanied with great *vital depression*, and occasionally absolute *syncope*. *Vomiting*, at first of the gastric and subsequently of the intestinal contents, and *complete constipation*, quickly supervene, the *abdomen* at the same time becoming *tender*, *swollen*, and *tympanitic*, and the interference with normal peristalsis causing the bowels to roll over each other with loud *borborygmus* and *gurgling;* the motions of the intestine, if the abdominal parietes be thin, may be felt or even seen externally, and may sometimes be observed to cease suddenly at some particular point which corresponds to the seat of obstruction. Unless relief be speedily obtained, death ensues—either from simple exhaustion, or, more commonly, from peritonitis, gangrene, or both —the duration of the case rarely exceeding a week or ten days; in cases of intussusception, the invaginated portion of gut is occasionally separated by sloughing, and discharged *per anum*, the continuity of the bowel being maintained by previously formed adhesions, and spontaneous recovery thus following.

Chronic Obstruction.—The most common causes of this variety of obstruction are (1) *fecal accumulations;* (2) *stricture of the bowel*, often of a malignant character; (3) *inflammatory changes in the bowel*, resulting from injury; (4) *chronic peritonitis* (often tuberculous), or *abdominal abscesses;* and (5) *abdominal tumors* of various kinds, which may compress and thus obstruct the adjacent portions of intestine.

Symptoms.—In the case of chronic obstruction, *constipation* is the most prominent sympton; there is seldom any acute *pain*, and comparatively slight constitutional disturbance, while the *vomiting* is not constant and does not assume a stercoraceous character until much later than in cases of the acute variety. *Abdominal distension*, though ultimately well marked, is slowly developed, and life may be prolonged for six weeks or more, recovery even being sometimes obtained after the persistence of complete obstruction for this period of time.

Statistics of Intestinal Obstruction.—The statistics of intestinal obstruction were particularly investigated by the late Dr. W. Brinton, who found, from an analysis of 12,000 post-mortem examinations taken promiscuously, that, excluding hernia, intestinal obstruction caused death in one out of 280 cases. Of the fatal cases of obstructed bowel, about 43 per cent. were due to the existence of intussusception; 31½ per cent. to internal strangulation (by bands, etc.); 17½ per cent. to strictures, or to tumors implicating the intestinal wall; and 8 per cent. to twisting of the gut upon itself.

The *locality* of the lesion was (in the case of *intussusception*) the junction of *ileum* and *cæcum* in 56 per cent., the *ileum* alone in 28 per cent., the *jejunum* in 4 per cent., and the *colon* in 12 per cent. of the whole number of instances. The corresponding percentages derived from Bulteau's statistics of 763 cases show for the *ileo-cæcal junction* 51.4 per cent., for the small intestine 28.8 per cent., and for the large intestine 19.8 per cent. In obstruction from *internal strangulation* (by bands, etc.), Brinton found the part affected to have been the *small intestine* in 95 per cent. of all cases; while, on the other hand, *strictures* and *twistings* involved the *large intestine* in 88 per cent. of all cases. Similar results are obtained from Bulteau's statistics. The sexes are almost equally liable to most of the causes of intestinal obstruction, but impacted gall-stones are four times as common in women as in men, while, on the other hand, according to Leichtenstern, intussusception is nearly twice as common in the male as in the female.

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[1] *Strangulated hernia*, which is perhaps the most frequent cause of acute intestinal obstruction, is treated of in Chap. XL., and is therefore omitted here.

Diagnosis.—It is of the utmost importance, in undertaking the treatment of a case of intestinal obstruction, to ascertain (1) whether it belongs to the *acute* or to the *chronic* variety, and (2) to what *cause* the obstruction is due. From Dr. Brinton's statistics, quoted above, it will be seen that of *acute* (fatal) cases rather more than half (43 to 39½) are due to intussusception, while of the remainder, about four-fifths are due to internal strangulation; and as the treatment of these conditions is not the same, their diagnosis becomes a matter of great interest.

Intussusception is by far the most frequent cause of obstruction met with among infants and young children, and is sometimes traceable to the disturbance created by polypi of the bowel, by intestinal worms, or even by masses of undigested food; it is especially characterized by a constant desire to go to stool, and by the discharge from the rectum of mucus, with liquid or coagulated blood. The perpetual desire to defecate is considered by Pollock almost pathognomonic of invagination. Stercoraceous vomiting is not as uniformly present in this as in other varieties of acute obstruction. In many cases, if the abdominal wall be thin, an elongated tumor, the shape of which has been compared to that of a sausage, may be distinctly felt by palpation, usually at the *left* side, and, in children at least, the invaginated gut may often be felt by the introduction of the finger into the rectum.

Internal Strangulation is most common in the periods of adolescence and early adult or middle life. Its most characteristic symptom is the occurrence of intense prostration or syncope.

Twisting of the Bowel is usually an affection of advanced life, and commonly involves the sigmoid flexure of the colon, its next most frequent seat being in the neighborhood of the ileo-cæcal valve. True *knotting of the bowel* has been observed in at least three cases, recorded by Parker, Gruber, and M. W. Taylor. In obstruction from twisting, the abdomen is, according to Erichsen, unevenly distended; one side being flattened, while the other is tympanitic.

Strictures or Tumors (causing *chronic* obstruction) affect the lower bowel much more commonly than the upper, and the diagnosis can usually be made by inquiring into the history of the case, and by an examination *per anum.* The history of the case will likewise serve for the purpose of diagnosis, should *acute* symptoms suddenly supervene under these circumstances.

In order to determine *what part of the intestinal canal is the seat of obstruction*, it is to be borne in mind that when the symptoms are *acute*, the lesion (unless the case be one of twisting of the gut) is usually situated in the *upper bowel*, while chronic obstruction commonly involves the *large intestine.* Obstruction *below* the descending colon can generally be recognized by careful exploration of the rectum. The period at which *stercoraceous vomiting* occurs is earlier in proportion to the greater proximity of the seat of obstruction to the pylorus; moreover, the higher the point at which peristalsis is arrested, the less, as a rule (according to Hilton, Bird, and Barlow), is the amount of *urine* secreted. Finally, careful *palpation* of the abdomen may, if the parietes be thin, serve to point out more or less exactly the point at which the bowel is obstructed.

TREATMENT OF INTESTINAL OBSTRUCTION.

Certain indications are common to *all* cases of intestinal obstruction.[1] Bearing in mind that the most desperate cases sometimes terminate in spontaneous recovery, the surgeon should in the first place endeavor to *obviate the tendency to death* by relieving pain, diminishing peristaltic action, preventing distension, and maintaining the patient's strength. The first and second objects are best accomplished by the free administration of *opium* (which may be advantageously combined with belladonna), and preferably in the solid form. From half a grain to a grain of the Extractum opii of the U. S. Pharmacopœia, may be given every three or four hours, or at such intervals as may be thought proper. The third and fourth objects are to be accomplished by the administration of *concentrated food* in small quantities and at frequent intervals. It is obviously desirable that, in order to prevent distension, the *bulk* of food, and especially of liquid, introduced into the stomach, should be as small as possible, and for the same reason the exhibition of *purgatives* by the mouth should be strictly interdicted. Large and repeated *enemata* of warm water, or, which Head prefers, warm oil,[2] administered through a long tube, are, on the other hand, of the greatest value, serving in different cases to effect disintegration of fecal accumulations, to alter the position of the bowel and thus cause the disappearance of a twist, or even possibly to relieve intussusception by pushing up the invaginated gut: the last-mentioned result could, however, only be attained in very recent cases, on account of the rapid formation of adhesions between the two portions of intestine which are involved. *Inflation of the large intestine with air*, introduced through the rectum by means of a long tube and stomach-pump, has occasionally proved successful in relieving the obstruction when all other measures have failed, and should certainly, I think, be resorted to in such cases. The application of electricity has also proved successful in cases recorded by Finny, Giommi, and others. The administration of *calomel*, in combination with opium, might be proper in case peritonitis should be developed at an early period; but under other circumstances should be avoided, as tending by its cathartic action to increase the distension of the bowel. *External manipulation* by gently rubbing and kneading the abdomen (*abdominal taxis*), has occasionally proved of service, and may be aided, as may the administration of enemata, by placing the patient upon the knees and elbows, or, in the case of an infant, by complete inversion. The external application of ice proved successful in some cases referred to by Habershon.

The special treatment of congenital malformations of the anus or rectum, of stricture or tumor involving the large intestine, and of abdominal abscess or tumor, compressing, though not directly implicating, the bowel—any of which conditions may lead to intestinal obstruction—will be considered in future pages. But supposing that the case is one of *acute* obstruction, resulting from either intussusception, internal strangulation, twisting, stricture of the small intestine, or the impaction of a foreign body, and that the course of treatment which has been recommended has been tried and failed, what is to be done? There is no time for delay, for these cases as a rule soon terminate fatally, and if any operation is to be done, it should not be postponed until the patient is at the point of death.

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[1] It is perhaps scarcely necessary to say that in *every* case of intestinal obstruction the surgeon should make a careful examination of all the localities in which hernia is apt to occur.

[2] Cases have been recorded by Libur and Jate, in which cures were effected by the successive injection of solutions of bicarbonate of sodium and of tartaric acid. Murray, of Newcastle-on-Tyne, and others, recommend enemata of ox-gall. An enema of iced water proved successful in a case recorded by Kormann, of Coburg.

Laparotomy, or, as it is more commonly though less accurately called, *Gastrotomy*,[1] the laying open of the abdominal cavity in order to search for and if possible remove the source of obstruction, has been resorted to in these cases, and is, I think, justifiable under certain circumstances. If, however, the case be one of *intussusception* (and this is, as has been seen, the cause of obstruction in the majority of acute cases), the surgeon will, in my judgment, usually best consult the interests of his patient by declining operative interference. My reasons for this opinion are, that (1) the tender age of many of the subjects of invagination renders them peculiarly ill adapted to support so grave an operation; (2) the operation, which is always one of a very serious nature, is particularly so in these cases, on account of the frequent existence of peritonitis as a complication; (3) the attempt to dislodge the invaginated bowel is very apt to fail; and (4) there is a fair probability of spontaneous recovery after sloughing of the invaginated gut. The latter point may be illustrated by Leichtenstern's statistics, which show that of 557 cases of which the termination is known, sloughing occurred in 149, of which 88 ended in recovery and 61 (41 per cent.) in death, while of the 408 in which sloughing did not occur, only 63 terminated favorably and 345 (85 per cent.) in death. The only cases of intussusception in which laparotomy seems to me to be justifiable are the rare instances in which the symptoms are those of *obstruction* merely, and not of *strangulation*. The operation has, I believe, been employed in 43 cases, 13 of which terminated successfully. The earliest age at which the operation has been successful is six months (Sands).

In cases of acute obstruction due to *causes other than intussusception*, there can be no doubt, I think, that laparotomy is justifiable, should other measures fail to give relief in the course of two or at most three days. There is, under such circumstances, no reasonable prospect of spontaneous recovery, and the only hope of cure in a case of persistent internal strangulation, which, next to invagination, is by far the most common lesion found in cases of acute obstruction, is in the employment of operative measures before the occurrence of general peritonitis or gangrene. Even in these cases, however, it may be well, before resorting to the knife, to try, as advised by Brinton, the effect of one or more *tobacco enemata*, and the surgeon, I may add, should take care not to mistake the constipation that attends *enteritis* or *peritonitis* for acute obstruction.

Laparotomy is thus performed: The patient, thoroughly etherized, is placed in the recumbent posture, his buttocks being brought to the foot of the operating table, and the contents of his bladder evacuated by catheterization; the temperature of the room should be previously raised to at least 70° Fahr. The surgeon may cut down directly upon the seat of obstruction, if the point at which this exists has been accurately determined, but should, under other circumstances, make his incision strictly in the median line, the wound extending from an inch below the umbilicus, longitudinally downwards for about four inches. The dissection is cautiously carried down to the peritoneum, in which membrane a small opening is then made, and enlarged as much as may be necessary with a probe-pointed bistoury introduced upon the finger as a director. Search is next to be made for the seat of obstruction, by carefully tracing downwards that portion of the bowel which is found distended. The source of strangulation having been discovered, the constriction is to be relieved, by the division or separation of bands or organized adhesions, or by withdrawing the strangulated gut from any pocket or fissure in which it may have been caught. If it should be found that the case is one of *volvulus*, the bowel may be carefully untwisted and replaced in its normal position. If the obstruction be due to the *impaction of a foreign body* or a gall-stone, the gut may be opened and the offending substance removed, the case being subsequently treated as one of wounded intestine (see page 381). If a *stricture of the intestine* be found (very rare except in the lower bowel, when a different operation would be indicated), the best that can be done is to lay open the gut above the stricture, and attach the margins of the aperture thus made to the edges of the external wound, in hope that the patient may recover with a fecal fistula. The same course should be pursued if the case be found to be one of *intussusception*, and if the firmness of the adhesions should prevent the relief of the invagination.

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[1] It is better, I think, to reserve the term *gastrotomy* for the operation of opening the *stomach* to remove a foreign body (page 383), designating the operation of abdominal section, in general, by the word *laparotomy* (from λαπάρα, the soft part of the body below the ribs).

Unless it be designed to attempt the establishment of a fecal fistula, the external wound should be immediately closed, upon the completion of the operation; the after-treatment consists in the adoption of means to combat the peritonitis which may be expected to arise.

The statistics of laparotomy for intestinal obstruction have been investigated by several writers, including Adelmann, Whitall, Sands, and myself. I have collected in all 230 cases, of which only 68 appear to have ended favorably.

OPERATION FOR	Cases.	Result not ascertained.	Recovered.	Died.
Volvulus, ...	14	1	4	9
Strangulation continuing after herniotomy or taxis, ...	18		6	12
Invagination, ...	43		13	30
Foreign bodies, impacted feces, gall-stones, etc.,	18	1	7	10
Strangulation by bands, adhesions, or diverticula,	76	1	20	55
Obstruction from tumors, strictures, ulcers, etc.,	28	2	7	19
Internal hernia and "ileus,"	20	1	7	12
Obstruction from other causes, ...	4		1	3
Cause of obstruction not ascertained, . . .	9	1	3	5
Aggregate, ...	230	7	68	155

Enterotomy for Acute Obstruction.—The operation which has just been described, is that which I would ordinarily recommend in cases of acute intestinal obstruction in which interference is deemed necessary. Other surgeons, however, including the late Mr. Maunder, have preferred a resort to *Enterotomy*, making an incision in the right iliac region, and opening the first coil of intestine which presents itself, so as to establish a fecal fistula. This operation involves much less interference with the peritoneal cavity than laparotomy, and may therefore be preferred in some cases as a palliative or euthanasial measure, but it could not be expected to afford permanent relief in cases of internal strangulation, while in cases of intussusception, *no* operation should, as a rule, be performed, for the reasons already mentioned.

Puncture of the Bowel with a delicate trocar or aspirator is recommended by Gross, Demarquay, and Wagstaffe, as a means of affording relief by allowing the escape of gas from the distended bowel. This procedure, which has occasionally been followed by complete recovery, is, however, not free from risk, death directly traceable to the operation having ensued in three out of ten cases recorded by Fräntzel, of Berlin.

Enterectomy, or resection of the affected portion of bowel, is recommended by some surgeons, and in a majority of the cases in which it has been performed is said to have ended in recovery.

Cases of Enterectomy.

No.	Operator.	Result.	No.	Operator.	Result.
1	Amitesarove,	Recovered.	16	Kocher,	Recovered.
2	Baum,	"	17	Id.	"
3	Berger,	Died.	18	Id.	Died.
4	Billroth,	Recovered.	19	Koeberle,	Recovered.
5	Id.	?	20	Langenbeck,	Died.
6	Byrd,	Recovered.	21	Ludwik,	Recovered.
7	Id.	"	22	Madelung,[1]	"
8	Cherni,	?	23	Minin,[1]	"
9	Czerny,	Recovered.	24	Neuhauss,	"
10	Id.	Died.	25	Périer,	Died.
11	Dittel,	Recovered.	26	Roggenbau,	Recovered.
12	Hagedorn,	"	27	Trélat,	?
13	Id.	"	28	Id.	?
14	Howse,	Died.	29	Id.	?
15	Julliard,	Recovered.	30	Wittelshöfer,	Died.

Operations for Chronic Obstruction; Colotomy.—In most instances, the cause of the obstruction in chronic cases can be detected by careful rectal exploration, when very simple treatment will often suffice to give relief; thus, if an accumulation of *hardened and impacted feces* be found in the lower bowel, repeated enemata must be employed, so as to soften and disintegrate the mass, removal being, if necessary, aided by the use of the finger, or, which is certainly more agreeable to the operator, a lithotomy scoop, or the handle of a teaspoon. In cases of obstruction dependent on *uterine* or *ovarian disease*, the surgeon should address his treatment to the organs primarily implicated. The cases of chronic obstruction demanding operative relief are chiefly those dependent on *stricture of the rectum*, whether malignant or otherwise, and the operation employed in these cases consists in the establishment of an artificial anus by opening the colon (*colotomy*), the part of the gut usually selected for this procedure being the sigmoid flexure. The operation of colotomy may also be occasionally required in certain cases of malformation of the lower bowel, of ulceration or cancerous disease of the rectum (even if unattended by obstruction), and of recto-vaginal or recto-vesical fistula. Colotomy may be performed by opening the *sigmoid flexure* in the *left iliac* region (as originally suggested by Littre, in 1710); the *cæcum* in the *right iliac* region (Pillore, 1776); the *sigmoid flexure* in the *left lumbar* region (Callisen, 1796); the *transverse colon* in the *umbilical* region (Fine, 1797); or, finally, the *cæcum*, in the *right lumbar* region.

Callisen's or Amussat's Operation.—The operation which is generally resorted to at the present day, and which is certainly the best in cases of chronic obstruction from stricture, etc., was suggested by Callisen and subsequently improved by Amussat, and consists in opening the colon in the left lumbar region—*Left Lumbar Colotomy;* the following directions for its performance are given by Allingham, and are founded upon the experience derived from more than fifty dissections, and from a large number of operations performed by that surgeon. Anæsthesia having been induced, the patient is fixed in the prone position with a slight inclination towards the right side, a hard pillow being placed under the left side, so as to render the loin tense and prominent. To determine the exact position of the colon, a point on the crest of the ilium, midway between the anterior superior and posterior superior spinous processes, is marked with iodine paint, the colon in the normal condition being always situated half an inch behind the point thus marked. The surgeon then, standing in front of the patient, makes an incision of at least four inches, midway between the last rib and the crest of the ilium, the centre of the wound corresponding exactly with the point which has been marked. The wound may be transverse, as recommended by Amussat, or, which is better, oblique, downwards and forwards in the course of the ribs, as advised by Bryant. The various tissues are carefully divided to the full extent of the external wound, until the lumbar fascia and edge of the quadratus lumborum muscle have been reached; the former being cut through, the colon usually presents itself, and may commonly be recognized, even if undistended, by the appearance of one of its longitudinal bands. Care must be taken not to open the peritoneum, which is sometimes inflated with gas, and simulates the appearance of the bowel. The operation is completed by introducing with a curved needle strong silken sutures, by means of which the gut is drawn to the surface, when it is incised in the direction of its long axis, to the extent of about an inch; the margins of the intestinal aperture are then stitched to the edges of the external wound, the sutures being retained until they begin to cut their way through by ulceration. Costallat divides the operation into two stages, not opening the bowel until several days after its exposure.

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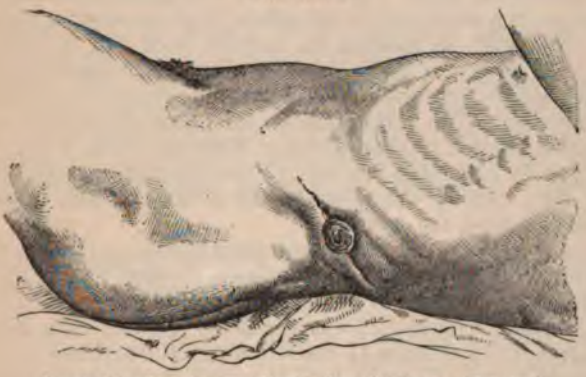
[1] Partial resection.

FIG. 447.



Result of lumbar colotomy, showing line of incision. (BRYANT.)

The great advantage of this operation over Littre's, is in the fact that the abdominal cavity is not opened, the colon being approached on that side which is uncovered by peritoneum; the operation is comparatively easy when the bowel is distended with feces, but under opposite circumstances (as when performed for stricture without obstruction) may be attended with considerable difficulty; it is a good plan in such a case to distend the gut with air before beginning the operation, so as, if possible, to render the position of the colon more apparent. Some inconvenience is usually at first experienced from prolapse of the bowel[1] through the artificial anus, but, as the tissues contract, the tendency to protrusion diminishes, and it may be ultimately necessary to adopt means to prevent the orifice from closing. To avoid the escape of fecal matter at inconvenient times, the patient should wear an obturator of ivory or other suitable material, attached to a gutta-percha plate, and held in position with a truss or bandage.

If the disease for which the operation is performed be situated *above* the sigmoid flexure (which may commonly be ascertained by noting the quantity of fluid which can be injected),[2] the *cæcum* should be opened in the *right lumbar* region by a similar procedure to that which has been described.

Littre's Operation, which is preferred by Studsgaard, Reeves, and several other surgeons, is a more simple procedure than Amussat's, particularly in children. It consists in making an incision from two to three inches in length, parallel to and a little above the line of Poupart's ligament, and midway between the anterior superior spinous process of the ilium and the spine of the pubis. The various tissues, including the peritoneum, are cautiously divided upon a grooved director, when the colon is drawn forwards and opened as in Amussat's method. This operation is usually performed on the *left* side, opening the *sigmoid flexure*, but may also be practised on the *right* side, opening the *cæcum*.

With regard to the *statistics* of these operations, it may be mentioned that Mr. Hawkins, from an analysis of all the cases which he was able to collect up to February, 1852, came to the conclusion that the proportion of recoveries after Amussat's operation was decidedly greater than after Littre's. Mr. Hawkins's tables contain 17 cases in which the peritoneum was opened, with 7 recoveries and 10 deaths, and 31 in which the peritoneum was not opened, with 17 recoveries and 14 deaths. Of 75 terminated cases of lumbar colotomy, tabulated by Dr. Mason, of New York, 53 ended in recovery, and only 22 in death. Van Erckelens has analyzed 262 cases of colotomy, 84 being examples of Littre's operation, with 39 deaths, and 165 of Amussat's, with only 63 deaths; the nature of the operation was unknown in 13 cases which gave six deaths. Bulteau gives 142 cases of lumbar colotomy with only 50 deaths. Mr. Curling's experience in lumbar colotomy is perhaps as large as that of any other living surgeon; of 21 cases reported by himself and his colleagues, 14 were successful, while 7 terminated fatally—though in some of these great relief was temporarily afforded. Mr. Allingham's experience has been equally satisfactory; of 10 terminated cases reported by this surgeon up to 1870, 6 are fairly regarded as successful, great relief was afforded in 3 more, and death resulted from the operation in only 1 instance.

When colotomy is performed for malignant disease of the rectum, permanent recovery cannot, of course, be anticipated, but, even as a means of affording temporary comfort, the operation should, in my judgment, be unhesitatingly resorted to in suitable cases. I would advise its performance (provided there were no special contra-indications) in any case of chronic obstruction from disease of the lower bowel, in which no benefit had resulted from a fair trial of judicious medical treatment.

[1] To prevent protrusion, Dr. Maclaren employs an "enterotomy tube" somewhat resembling Sir Henry Thompson's supra-pubic vesical tube for prostatic hypertrophy.

[2] Mr. T. P. Teale recommends laparotomy as an exploratory operation to ascertain on which side the colon should be opened, a preliminary measure which seems to me as dangerous as it is unnecessary.

Colectomy, or excision of a constricted portion of large intestine, appears to have been resorted to in nine cases, four of which have ended in recovery. The successful operators have been Reybard, Czerny, Martini, and Bryant. Gussenbauer's, Baum's, Schede's, Guyon's, and Marshall's cases terminated fatally.

MALFORMATIONS OF THE ANUS AND RECTUM.

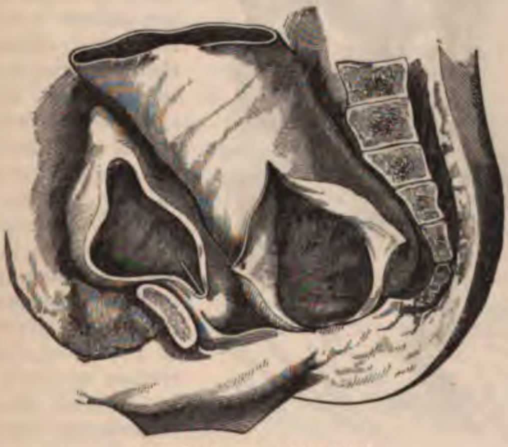
The surgeon is not unfrequently called upon to attempt the relief of congenital malformations of the lower bowel, which, unless remedied by operation, will inevitably lead to fatal intestinal obstruction.

Partial Occlusion of the Anus.—In this condition the anus, though not entirely occluded, yet presents so minute an orifice as not to permit the free escape of feces. The *diagnosis* of this from the more serious conditions which will be presently described, can be made by careful inspection, which will reveal a passage admitting the introduction of a probe. The *treatment* consists in enlarging the orifice by making radiating incisions with a probe-pointed knife, dilatation being subsequently maintained by the occasional use of a bougie.

Complete Occlusion of the Anus.—In this variety of malformation the anus is closed by a membrane of greater or less thickness, through which the meconium may be seen, and which bulges when the child struggles or cries. The *treatment* consists in making a crucial incision, excising the flaps thus formed, and bringing the skin and mucous membrane together with fine stitches—a bougie being passed from time to time to maintain the opening in a patulous condition.

Imperforate Anus.—Here the anus is completely absent, its normal position being occupied by a dense fibro-cellular mass, from a quarter of an inch to an inch in thickness, behind which the rectum terminates in a blind pouch. The *treatment* consists in making an incision of about an inch in length, forwards from the coccyx, in the direction of the raphe of the peri-

FIG. 448.



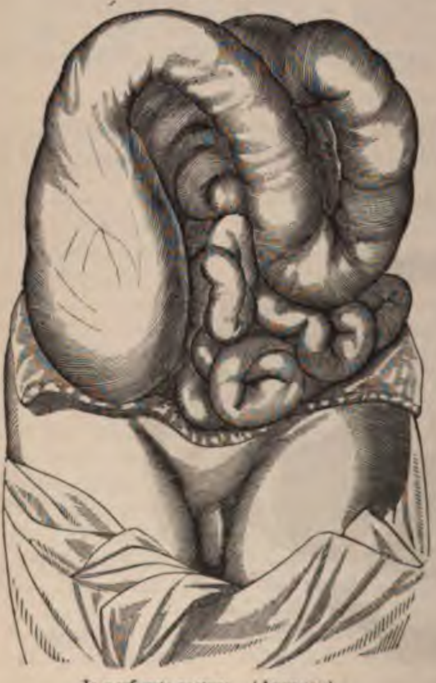
Imperforate anus. (ASHTON.)

neum. The wound is then cautiously deepened, in the median line, following the curve of the sacrum until the gut is reached, when a free opening is to be made, and the meconium evacuated. The mucous lining of the rectum is then to be drawn downwards (if possible) to the external wound, and attached to the skin with sutures. The use of bougies is subsequently required to maintain dilatation.

Occlusion of the Rectum.—The anus is well formed, and the nature of the case, is, therefore, probably not suspected until after the development of symptoms of intestinal obstruction, when the diagnosis may be readily made by the introduction of the finger or a probe, the instrument coming in contact with a bulging membranous septum, from half an inch to an inch above the anal orifice. The *treatment* consists in making a small incision to evacuate the meconium, the wound being subsequently dilated with dressing-forceps or enlarged with a concealed bistoury. The use of the bougie must be continued daily for some months. If the operation is attended with much bleeding, plugging of the rectum should be resorted to. Pearce-Gould has reported a curious case of congenital occlusion of the rectum by an *inspissated plug of mucus*, in which enterotomy was resorted to with a fatal result.

Imperforate Rectum.—In this condition the whole rectum is wanting, the anus being usually likewise imperforate. The colon terminates in a dilated pouch, in the iliac fossa, or opposite the promontory of the sacrum. The diagnosis of this condition from that of imperforate anus, is always difficult, and often impossible. It may in some cases be facilitated by careful palpation of the abdomen, or (as suggested by Holmes) by introducing a sound into the bladder (or vagina, if the patient be a female), when, if the instrument impinge indirectly on the posterior wall of the pelvis, it may be inferred that the rectum is totally absent. In the *treatment* of these cases, the surgeon has four operations to choose from, viz., (1) puncture with an aspirator, over the needle of which a small canula may be afterwards pushed in, and the passage thus gradually dilated, as advised by Grimes, of Liverpool, (2) cautious dissection upwards from the perineum (as recommended for imperforate anus), (3) Littre's operation of opening the colon in the iliac region, and (4) lumbar colotomy by the method of Callisen and Amussat. In case of failure to reach the gut by means of the aspirator, the *perineal operation* should be chosen, unless it is evident that the bowel cannot be reached in this direc-

FIG. 449.



Imperforate rectum. (ASHTON.)

tion. It is performed in the manner already described, great care being taken not to wound the bladder, vagina, peritoneum, or iliac vessels. If the gut can be reached, its mucous lining should, if possible, be drawn downward and attached to the edges of the external wound—as otherwise, apart from the danger attending the passage of the meconium over a raw surface, the artificial canal will be apt to contract into a narrow and troublesome sinus. Verneuil recommends that the coccyx itself should be excised in these cases, as a preliminary to searching for the bowel; he has himself adopted this plan in several cases with a successful result.

If, however, it be evident that no attempt to reach the bowel from the perineum can succeed, or if the attempt have been made and have failed, the only remaining course of treatment is to open the colon by one or other of the methods already described. I cannot subscribe to the doctrine that it is more merciful to abandon a child to certain death than to strive to save his life by the formation of an artificial anus; on the contrary, it is, in my judgment, the surgeon's duty, in these cases, to urge the performance of this operation, on the same principles as those which guide him to recommend tracheotomy in a case of occlusion of the larynx, or amputation in one of hopeless disorganization of a limb.

With regard to the particular mode of opening the colon in these cases, some difference of opinion exists. Amussat's operation in the *left lumbar region* is usually preferred, but is less apt to succeed in these cases than in those of chronic obstruction in adults, on account of the frequent existence in infants of a long meso-colon, which, by allowing the bowel to float, as it were, may render it impossible to complete the operation without opening the peritoneum; hence Erichsen is disposed to think that it may be better in these cases to open the cæcum on the *right* side, instead of the descending colon on the left. Mr. Holmes, whose opinion on all subjects relating to the surgery of childhood is of the greatest value, gives a decided preference to Littre's operation, because (1) the operation is easier, the abdominal wall in the infant being thin, while the fat and other tissues of the loin are very deep; (2) the colon often cannot be reached from the loin without opening the peritoneum, and (3) the descending colon, in cases of imperforate rectum, is often so short that it might not be reached at all by Amussat's operation, unless the incision were made so high as to endanger the kidney; hence Mr. Holmes recommends colotomy from the *left groin*, and similar advice is given by Mr. Curling. Finally, Huguier advises that the colon should be opened by an incision in the iliac region of the *right* side. Upon the whole, I think that the weight of evidence is in favor of Littre's operation, and it is that which I should recommend in any case in which it was found impossible to reach the bowel from the perineum. Should the child survive, in a case of this kind, it would be proper to attempt the restoration of the natural passage by Demarquay's plan of passing a thread carrying a leaden ball through the artificial anus and out at the peritoneum, so as gradually to draw the gut downwards. A similar operation, using, however, an elastic bulb instead of a leaden ball, has been successfully employed by W. A. Byrd, of Illinois.

Congenital Malformations with Abnormal Openings in other Parts.— The several varieties of malformation which have been described, may be complicated by the existence of an abnormal communication between the gut and other parts; thus the bowel may open into the bladder or urethra, or into the vagina, according to the sex of the infant, or upon the surface of the body, sometimes at a considerable distance from the natural position of the anus.

The *treatment* of such cases consists in restoring the natural passage (if possible), when the abnormal opening will usually heal of itself, or, if not, may be closed at some future time by a plastic operation. When the gut opens into the *vagina*, the treatment may be facilitated by introducing a director through the fistulous orifice, and carrying it downwards towards the perineum; its point may then be cut down upon, and the skin and mucous membrane stitched together in the way already described. Should the bowel communicate with the *bladder* or *urethra*, the case may be one of greater difficulty; if, in such a case, the natural passage cannot be restored, a free perineal incision should be made, as in the operation of lithotomy, laying open the neck of the bladder or membranous portion of the urethra, whichever may be involved, so as to afford a direct outlet for the meconium and feces. If the gut open on the *surface of the body*, the question of operative interference turns on the position of the abnormal opening; if this be in a situation in which no particular inconvenience would result from the deformity (as immediately in front of the coccyx), or, on the other hand, in such a locality as to render it probable that a great part of the large intestine is absent (as in the iliac or umbilical region), the safest plan will be to decline an operation, merely dilating the abnormal aperture so as to prevent fecal accumulation; if, however, the gut open in the anterior part of the perineum, or in the scrotum, the rectum will be found at a short distance beneath the integument, and may be readily reached by an incision in the ordinary position of the anus. In a case recorded by Miss Susan Dimock, in which, after the operation, fecal incontinence continued, the normal and abnormal openings were found to be both within the limits of the sphincter, and a cure was effected by simply dividing the tissues by which they were separated.

Before operating in any of the more complicated cases of rectal malformation, it may be well, if the symptoms of the case are not urgent, to wait a day in order to allow the gut to become distended, as it will then be more easily reached than if it be in flaccid condition.

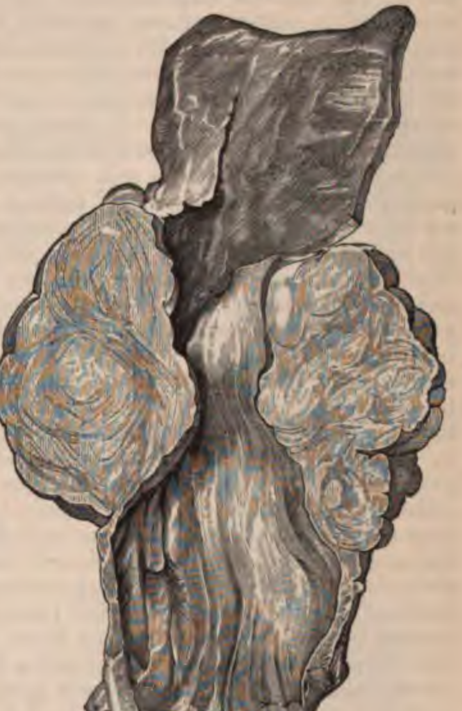
Stricture and Tumors of the Rectum and Anus.

Any part of the large intestine may be the seat of stricture, but it is by far most commonly met with an inch or two above the anus, or just below the junction of the rectum and sigmoid flexure of the colon. Three forms of rectal stricture may be described, viz., the *simple*, the *warty*, and the *malignant*.

Simple or Fibrous Stricture.—The constriction (which appears to be due to the presence of an adventitious structure of a fibrous character) is usually seated in the submucous areolar tissue, but more rarely in the muscular coat, or even in the mucous lining of the bowel. The *extent* of the stricture varies from a few lines to an inch or more, the whole calibre of the gut being commonly involved, though not unfrequently the induration and thickening are most marked on one side. The *causes* of this form of stricture are chiefly *inflammation* or *ulceration* of the part, whether arising from chronic *dysentery*, from previous *prolapsus*, from *wounds*, from the irritation caused by *fecal accumulations* or *foreign bodies*, or from the contact of *gonorrhœal* or *leucorrhœal* discharges. In other instances, stricture of the rectum may follow the cicatrization of a *chancroid*, or may occur as a *syphilitic* lesion, almost invariably, in this case, as a secondary or tertiary phenomenon. The fibrous stricture appears to be more common in women than in men.

Symptoms.—The symptoms of stricture of the rectum are difficult and painful defecation (the feces being flattened and ribbon-like, or, more commonly, passed in the form of scybala, mingled with mucus and perhaps blood), followed by various dyspeptic phenomena, and ultimately by the evidences of intestinal obstruction. Abscesses not unfrequently form in the areolar tissue around the gut, and communicate with the bowel either above or below the stricture, opening into the vagina, in the perineum, or in the gluteal region, and giving rise to intractable fistulæ, which contribute much to the discomfort and exhaustion of the patient. In other cases, the formation of fistulæ is due to the escape of fecal matter through ulceration of the bowel above the seat of stricture. The more solid portions of the feces are detained above the stricture, the gut at this point becoming dilated into the form of a pouch; while the more liquid portions mingled with mucus or muco-pus find their way through the contracted part, leading the patient not unfrequently to complain of diarrhœa. When *intestinal obstruction* occurs, its symptoms may be gradaully developed, or may be suddenly manifested owing to the complete occlusion of the gut by the lodgement of a fish-bone or other foreign body.

FIG. 450.



Fibrous stricture of the rectum. (ASHTON.)

Diagnosis.—The diagnosis of stricture of the rectum, when the seat of constriction is within three or four inches of the anus, can usually be readily made by digital examination, the finger being well oiled, and passed with the utmost gentleness. When the stricture is at a higher point, it may often be brought within reach by directing the patient to bear down, or by making the examination while he is in the upright posture, or as advised by Simon, the whole hand may be introduced, while the patient is in a state of anæsthesia, and exploration thus carried as high as the sigmoid flexure. The last-mentioned mode of exploration is, however, as pointed out by Dittel, Weir, and Dandridge, not free from risk, and the latter surgeon has collected four cases, including one of his own, in which lacerations of the bowel were thus produced. Fatal peritonitis from rupture of a splenic cyst has followed the same procedure in the hands of Dr. Briddon. The introduction of a bougie is not of much value for diagnostic purposes, as it is apt to catch in some of the folds of the rectum, or to strike the promontory of the sacrum, and thus lead to error; while the subjective symptoms noted by the patient are extremely deceptive, many cases which

Dr. Van Buren has well described as "phantom strictures" being no strictures at all, but simply cases of deficient tone and action of the lower bowel. In making a digital examination, the surgeon should bear in mind that the rectum may be compressed by objects external to itself, as an enlarged prostate, a retroverted uterus, various forms of tumor, enlarged lymphatic glands, abscesses, etc.

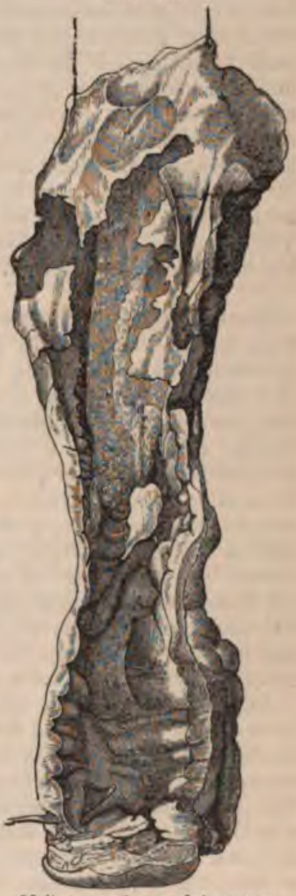
Treatment.—The treatment of rectal stricture is both general and local. The *general treatment* consists in maintaining the state of the patient's health, in keeping the bowels in a soluble condition by regulation of the diet and the administration of mild laxatives or emollient enemata, and in relieving pain by the the use of opium, particularly in the form of suppositories. Iodide of potassium would be indicated in a case of syphilitic origin. The *local treatment* consists in endeavoring to restore the part to its normal calibre by the cautious employment of oiled *bougies* of gradually increasing sizes; and in obstinate cases, especially if of traumatic origin, by making slight radiating *incisions* with a blunt-pointed bistoury. Rectal bougies are ordinarily best made of India-rubber, and should invariably be used with the greatest caution, lest laceration, or even perforation, of the bowel ensue. A bougie, of such a size as to be firmly grasped by the stricture, should be chosen, and may be introduced every third or fourth day, being left in for fifteen or twenty minutes on each occasion. After its withdrawal an opium suppository should be inserted, if possible above the stricture. If incisions are required, the knife should be introduced, guided and guarded by the left forefinger, the stricture being simply notched at several points, though Whitehead, Lente, and Beane prefer free incisions in the median line, posteriorly in the case of a male, and both posteriorly and anteriorly in that of a female. A bougie may then be passed, and followed in a few minutes by an opium suppository, the patient being kept at rest for a day or two subsequently. In the after-treatment, Whitehead employs an India-rubber bag (such as that used by Bushe in cases of rectal hemorrhage), distending it with warm water after its introduction; a similar apparatus is employed by Wales. Various ingenious modes of effecting *rapid dilatation* have been proposed by surgeons, but are, I believe, more dangerous, and not more satisfactory, than the use of the simple bougie, which, though it may perhaps never accomplish an absolute cure of rectal stricture, affords in many instances very decided relief. Verneuil has introduced an operation, under the name of *linear rectotomy*, which consists in freely dividing the stricture together with the lower part of the rectum, including the sphincter. The section is effected with either the knife or the *écraseur* (the chain of the instrument being introduced through a fistula, if there be one extending above the stricture), and the division is made by preference at the posterior part of the gut and in the median line; the wound should not extend more than ten centimetres (about four inches) above the anus, for fear of wounding the peritoneum. Kelsey has collected 19 cases in which this operation has been resorted to, and in most instances with decided benefit to the patient; it is a mode of treatment only applicable, of course, to cases of constriction situated within a short distance of the anus, and even in them should, it seems to me, be looked upon as a last resource. Trélat has modified this operation by employing the galvanic cautery, and in other cases by using an elastic ligature. *Excision* of the contracted portion of bowel has been practised by Lowson, of Huddersfield, but with somewhat doubtful advantage.

Should symptoms of intestinal obstruction come on, an attempt should be made to relieve the patient by the administration of copious enemata, etc. (p. 833), or, if necessary, by rectotomy, or by opening the colon, either in the left or right loin, according to the seat of constriction.

Warty Stricture.—A peculiar form of rectal stricture, which might be appropriately called *warty*, has been described by Brodie, Curling, H. Lee, and others, in which numerous excrescences, resembling condylomata, occupy the margin of the anus and the interior of the gut, below the seat of stricture. These cases are believed by Gosselin to be of syphilitic origin. The profuse muco-purulent discharge, which is the most annoying complication of this form of stricture, may be somewhat controlled by the use of astringent injections and the application of a solution of nitrate of silver.

Malignant Stricture.—In this form of stricture, the obstruction is due to a cancerous (usually scirrhous or encephaloid) growth, which may originate as an independent tumor, or as an infiltration in the tissues of the bowel.[1] The *symptoms* do not at first materially differ from those of simple stricture, though the diagnosis can be made by digital examination, the induration of the malignant growth being of an irregular and nodulated character. When ulceration occurs, the act of defecation is commonly attended with great pain and a burning sensation, extending to the loins and thighs, the discharges containing a considerable quantity of pus and blood. Digital examination at this time reveals a soft, fungous mass, and the finger is withdrawn, smeared with blood. As the cancerous tumor grows, it frequently involves neighboring parts, as the vagina or bladder, giving rise, perhaps, to vesico-rectal or vagino-rectal fistula, and thus rendering the patient additionally miserable. By compressing the iliac veins, the tumor causes œdema of the lower extremities. Death may ensue from gradual exhaustion, at the end, perhaps, of three or four years, or at an earlier period from the occurrence of intestinal obstruction.

FIG. 451.



Malignant stricture of the rectum. (ASHTON.)

The *treatment* must be merely palliative, any attempts to excise or tear away the malignant growth being (in my judgment) totally unjustifiable, and usually leading to a speedy death from peritonitis or hemorrhage. Pain is to be alleviated by the free use of *anodynes* (by suppository or otherwise), and fecal accumulation to be prevented by the occasional use of *laxatives*. Emollient *enemata* may sometimes afford relief, but great care must be taken, in their employment, not to inflict injury on the bowel. *Bougies* may be cautiously employed before ulceration has begun, but at a later period could only be productive of mischief. *Linear rectotomy* is recommended by Verneuil and Kelsey, but, I confess, seems to me not a very promising mode of treatment; and I must say the same of Volkmann's and Gay's proposal, to remove the growth with a circular portion of the rectum, and stitch together the divided portions of the bowel. Finally, *lumbar colotomy* may be properly resorted to, either to relieve obstruction or to obviate the suffering caused by the passage of feces over the ulcerated surface.

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[1] According to Cripps and Holmes, however, many cases called cancer of the rectum are really of an adenoid character.

Malignant Disease of the Anus.—This, when primary, is commonly of an epitheliomatous character, though the anus may become secondarily involved in cases of cancer of the rectum. Epithelioma of the anus, if recognized at an early period, may occasionally be excised with advantage, the diseased part being held up by two tenacula, which are then freely dissected out, as advised by H. Lee; but in a more advanced stage of the affection, palliative treatment is alone justifiable. Here, as in cancer of the rectum, great comfort may be occasionally afforded by a resort to *lumbar colotomy*. *Extirpation of the lower end of the rectum* has been practised by Verneuil, Billroth, Levis, Agnew, Briddon, J. R. Wood, Keyes, Moore, Vanderveer, Post, and numerous other surgeons; in some instances with at least temporary advantage, but in a considerable proportion of cases with a fatal result, 140 cases collected by Kelsey having given 22 deaths as the immediate result of the operation, and only about the same number of permanent recoveries. It is usually advised to bring the resected gut down and attach it to the surrounding integument by means of sutures, but, according to Cripps and Vanderveer, this is unnecessary, it being better to rely upon frequent syringing to prevent irritation of the wound by the contact of fecal matter.

Non-malignant Tumors of the Rectum.—These are commonly of a fibrous, fibro-cellular, or adenoid character, occasionally sessile, but more often pedunculated, constituting the affection known as *polypus of the rectum.*

Rectal polypus is most common in children (though rare at any age), and may, unless the examination is made with care, be mistaken for a hemorrhoidal tumor, or for a prolapse of the mucous coat of the bowel. The polypus often protrudes through the anus at the time of defecation, and is frequently attended with hemorrhage; it may exist as a complication of the *painful ulcer* or *fissure of the rectum.* The *treatment* consists in the application of a firm ligature, so as to strangulate the growth, which may then be cut off below the point of ligation, or, which is safer, may be pushed above the sphincter, an opium suppository being then administered to prevent straining and to relieve pain. The strangulated mass becomes detached, and is passed at stool in the course of a few days. Excision, without previous ligation, should be avoided on account of the risk of hemorrhage.

Sessile growths may be treated in the same way (the base being transfixed by a double ligature and tied in two halves), or may be more speedily removed by means of the *écraseur.* A vascular tumor of a *papillary* or *villous* character has been described as occurring in the rectum by Quain, H. Smith, Allingham, and other writers. It is usually attended with constant, and sometimes with profuse, hemorrhage, which gradually exhausts the patient. Repeated applications of strong nitric acid effected a cure in the case observed by Mr. Smith, but in most instances the ligature would probably be a surer mode of treatment. A *dermoid cyst* in the rectum has been met with in one instance recorded by Danzel.

Enterotomy has been advantageously employed by Sklifosovski in a case of multiple polypoid excrescences of the rectum and colon.

RECTAL FISTULÆ.

The rectum may communicate with the bladder or urethra in the male, and with the vagina in the female.

Recto-Vesical and Recto-Urethral Fistulæ may depend upon congenital malformation, or may be caused by ulceration, usually of a malignant character, or by wounds accidentally inflicted, as in the operation of lithotomy. Recto-urethral fistula may also be due to the careless use of a bougie, or to the bursting of a prostatic abscess. The symptoms are sufficiently evident; urine escapes into the gut, and, by flowing over the nates, produces excoriation; while, if the opening be large, fecal matter may enter the bladder, giving rise to cystitis and vesical tenesmus. When the fistula is due to the ulceration of a malignant growth, little can be done in the way of *treatment*, beyond the adoption of mere palliative measures, lumbar colotomy being justifiable when the feces escape into the bladder. In other cases, however, an attempt may be made to close the fistula, if small, by occasionally touching the part with nitrate of silver or with the galvanic cautery, while, if more extensive, a plastic operation may be tried, the fistula being exposed by means of a duck-billed speculum, and its edges pared and brought together in a transverse direction; the bladder should be subsequently kept empty by the frequent use of a gum-elastic catheter, and the bowels locked up by means of opium suppositories. The patients in these cases should be taught, before the operation, to introduce the catheter for themselves, so that there may be no occasion for urine to flow over the wound until cicatrization is completed. Advantage may be sometimes derived from keeping the patient in the prone position, and in one instance Sir H. Thompson succeeded in effecting a cure by this alone. As a last resort, a large staff may be introduced into the urethra, and the sphincter ani divided upon this so as to lay the parts freely open; the patient should then be placed in the prone position, and a catheter retained in the bladder while the wound is allowed to heal by granulation.

Recto-Vaginal Fistula may depend upon congenital deformity, or upon abscess or ulceration affecting the recto-vaginal septum, sometimes in connection with rectal stricture; but its most frequent cause probably is injury received during parturition. The *treatment* consists in cauterization (if the fistula be small), or in the closure of the opening by means of a plastic operation, which is thus performed: The contents of the rectum and bladder having been evacuated, the patient is thoroughly etherized and secured in the lithotomy position; the fistula is next exposed by drawing upwards the anterior wall of the vagina with a duck-billed speculum, and the edges are obliquely pared, the vaginal mucous membrane being dissected off in an extent of four lines around the aperture; a sufficient number of deep and superficial sutures are then introduced to bring the freshened edges of the fistula accurately together in a transverse direction. Copeland, Brown, and Erichsen, advise that the sphincter ani should be divided, so as to prevent the contraction of this part from interfering with the healing process. The sutures may be of silk, or (which is better) of silver, or flexible iron wire; if of silk, they should be removed about the sixth day, but if of metal, may be allowed to remain several days longer. The bowels should be locked up with opium for nearly a fortnight. Other modes of treatment consist in laying open the recto-vaginal septum below the fistula by incision, the parts being allowed to heal by granulation, or in introducing a ligature which is daily tightened until it cuts its way through. The late J. R. Barton, of this city, and, more recently, Taylor, of New York, have recommended simple division of the sphincter ani, as in the treatment of fistula in ano; this mode of treatment is also applicable to cases in which the gut communicates by a fistulous track with one of the labia majora, constituting *Recto-labial Fistula.* When recto-vaginal fistula follows upon stricture of the rectum, this must be fully dilated before any operation upon the fistula is attempted.

Entero-Vaginal Fistula, in which the small intestine opens into the vagina, its communication with the lower bowel being interrupted, is a rare condition which obviously does not admit of operative relief.

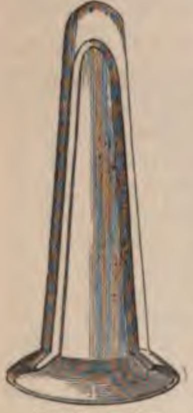
FISTULA IN ANO.

This common and distressing affection consists in an abnormal communication between the rectum and some point on the external surface, usually in the space between the anus and the tuberosity of the ischium.

Causes.—Fistula in ano may originate in *ulceration and perforation of the mucous membrane of the gut,* as the result of the irritation produced by fecal accumulations (as in rectal stricture), or by foreign bodies, such as fish-bones or grape-seeds; it may also be traceable to an *abscess* which occurs externally to the bowel, in the ischio-rectal fossa, and is caused by injuries, such as blows or kicks upon the anus, or by exposure to cold, as from sitting upon wet grass or stones, or which arises from suppuration around the prostate, or in a lymphatic gland.

Varieties.—Three forms are recognized by systematic writers, viz., (1) the *complete* fistula, in which there are two openings, one in the gut, and one on the surface of the body; (2) the *incomplete external* fistula, in which there is no inner opening, though the fistulous track can usually be traced to just beneath the mucous membrane; and (3) the *incomplete internal* fistula, in which the sinus communicates with the gut, but not with the external surface. The second and third varieties are also spoken of as *blind fistulæ.*

FIG. 452.



Rectal speculum.

Symptoms.—The position of the external orifice is usually marked by a prominent papilla or granulation, while the internal opening can be felt by the finger in the rectum, or may be seen by the aid of the rectal speculum (Fig. 452). There is a discharge of thin pus from the fistula, producing excoriation of the surrounding parts, which are commonly thickened and indurated. The fistula sometimes runs a pretty straight course, but is often tortuous and bent upon itself, being superficial from the external orifice to the margin of the sphincter, and then passing up deeply by the side of the bowel. There may be several sinuses opening externally, but all communicating with the same principal track; or there may be two or more independent fistulæ in the same case. Occasionally a slight form of fistula is met with, which opens at the margin of the anus within the position of the sphincter; but in the true "fistula in ano," the external orifice is an inch or more distant from the anus, while the track of the fistula passes through or more frequently quite outside of the sphincter.

Diagnosis.—This can readily be made by introducing a probe through the external opening, while the finger is placed in the rectum; the track of the fistula can thus be traced with a little trouble to its internal opening, which will almost invariably be found just above the internal sphincter, though a sinus may extend some distance further up the bowel. If there be no internal opening, the probe can be felt in the same locality, immediately beneath the mucous lining of the gut. In cases of *blind internal* fistula a bent probe may be introduced through the inner opening (which may be brought into view by the aid of the speculum) and carried downwards in the direction of the fistulous track; in these cases, too, pressure on the external surface will cause an escape of pus into the bowel. It must be remembered that every sinus in the neighborhood of the anus is not necessarily a fistula in ano; it may, for instance, be connected with caries or necrosis of the tuber ischii; may depend upon the presence of a tuft of hair, as in curious cases[1] observed by J. M. Warren and other surgeons, including Lamadrid, Gaston, and myself; or may communicate with an abscess arising within the pelvis, or proceeding from the hip-joint.

Treatment.—The formation of a fistula in ano may sometimes be *prevented* by the dilatation with bougies of any rectal stricture that may exist, and by the prompt treatment of inflammation or abscess in the ischio-rectal space. If the surgeon be called in before suppuration has actually occurred, the formation of an ischio-rectal abscess may perhaps be arrested by the assiduous use of poultices or warm fomentations, but if matter be present, it should be at once evacuated by a sufficiently free and deep incision, when the part may possibly heal without forming a communication with the gut.

The treatment of fistula in ano may consist (1) in the employment of *stimulating applications*, such as nitrate of silver or the tincture of iodine; (2) in the use of a *ligature*, tied so as to strangulate the tissues intervening between the fistula and the surface of the body, and tightened every few days until it cuts its way through by ulceration; and (3) in *incision*, or the "*operation for fistula*." The first and second methods are chiefly applicable to those cases in which, from the constitutional condition of the patient, or from his fear of the knife, any cutting operation is contra-indicated. The use of an *elastic ligature* is recommended by Dittel, Courty, and Allingham, and the latter has devised an ingenious instrument to facilitate its introduction.

There is some difference of opinion among surgeons as to the propriety of operating for fistula in ano in the case of *phthisical* patients, many writers deprecating interference under these circumstances, on the ground that the fistula acts a useful part as a source of revulsion or counter-irritation, while others advise the operation, in the belief that every additional drain upon the system must be injurious. It seems to me that this question should be decided, in each individual case, according to the stage and extent of the constitutional affection, and the degree of annoyance caused by the local disease. In a case of advanced phthisis, unless the discomfort produced by the fistula were unusually great, it would doubtless be more prudent to decline an operation—but under other circumstances, a different course may be proper. The mere existence of tubercle is not in itself a contra-indication, and there is in many instances reason to hope that by curing the local affection, the progress of the constitutional disease may be retarded, if not completely arrested.

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[1] See an admirable paper on "Coccygeal Fistula," by Heurtaux, in Bull. et Mém. de la Société de Chirurgie, Avril 5, 1882.

When fistula in ano is dependent upon *stricture of the rectum*, no operation for the relief of the fistula should be performed until the stricture has been properly dilated, and if the stricture be of a malignant character, the operation is positively contra-indicated.

The Operation for Fistula in Ano consists in dividing the sphincter, with the tissues between the external orifice of the fistula and the anus. It is not necessary to give ether in this operation, unless the patient particularly desire it, but there is no objection to its use, and it should always be employed if there are several external openings, rendering the operation unusually complicated and tedious. The rectum having been emptied by an enema, the patient is placed on the side corresponding to that of the fistula, with his buttocks at the edge of the bed or table, and held apart by an assistant. If there be several sinuses communicating with one fistula, these should be laid open on a grooved director; but in the majority of instances there is but a single external opening. Through this the surgeon introduces his director, slightly bent at the extremity, and passes it up in the track of the fistula until it projects through the internal opening into the gut, where it can be felt by the forefinger[1] inserted into the rectum. The internal opening of the fistula will almost invariably be found just above the sphincter ani, even though the fistula itself extend some distance further along the bowel; if, however, no opening be found here, one should be made by thrusting the director through the rectal mucous membrane, it being quite unnecessary and not very safe to extend the incision higher up. The point of the director being felt in the rectum, is to be hooked down by the finger and brought out through the anus, thus raising the sphincter and other parts to be divided upon the groove of the instrument, which is then cut loose by a few strokes with a sharp scalpel. The whole surface of the wound should then be wiped with the solid stick of nitrate of silver, or caustic potassa, so as to check oozing, and by making a superficial eschar, prevent premature adhesion of the edges. A strip of oiled lint is finally laid in the wound, which is allowed to heal by granulation, a probe being occasionally passed between its edges to prevent their uniting superficially and thus reproducing the fistula.

The patient should be kept in bed for a few days after the operation, the bowels being locked up by opium for about forty-eight hours, when a full dose of castor oil may be administered. I have never met with troublesome hemorrhage either during or after this operation, but if it should occur (as it may, if the incision be carried too high, from wound of the hemorrhoidal vessels), it must be controlled by compression or by styptics, or, if a bleeding vessel can be found, by the application of a ligature.

If the fistula be of the *blind internal* variety, an external opening may be made by cutting upon the point of a director introduced from within, the subsequent steps of the operation being conducted in the way already described.

Other modes of operating are frequently resorted to, but the principle is the same in all. Gross and Allingham, after passing the director, cut from within outwards with a curved bistoury introduced along the groove of the instrument, while many other surgeons, and perhaps the majority, employ a probe-pointed bistoury, and dispense with the director altogether. Brodie, and more recently W. Cooke, have preferred to divide the sphincter with scissors, while Hewson and others use the "syringotome," or, as Syme not inaptly called it, the "probe-razor." Mr. Reeves after dividing the sphincter and freshening the fistula, closes the latter with sutures, somewhat as in the operation for ruptured perineum.

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[1] In making digital examinations of either rectum or vagina, the finger should be well oiled, and the depressions around the nail filled with soap, or simple cerate, so as to prevent the adhesion of any offensive substance.

If there should be more than one fistula, there would be reason to fear that a multiple division of the sphincter might entail subsequent fecal incontinence. Hence, in such a case, the *elastic ligature* may be used in preference to the knife, or the knife may be used on one side and the ligature on the other. Felix, of Brussels, employs a ligature drawn rapidly backwards and forwards so as to cut its way through, in the manner of the *hemp-saw* recommended for uterine polypi by McClintock, of Dublin.

Fissures and Ulcers of the Anus.

Several distinct affections are often included under these names.

1. **Fissures, Chaps, or Cracks,** may exist in the thin skin around the anus, without at all implicating the mucous membrane. These may follow upon herpetic or eczematous eruptions of the part, or may be produced by the acridity of the intestinal discharges, want of cleanliness, etc. In their worst form, these fissures or chaps constitute the *rhagades* often seen in prostitutes, and therefore commonly supposed to be of syphilitic origin, though it is probable that, in many instances, they are due rather to the irritating contact of vaginal discharges, and to a neglect of ablutions. Though these fissures are productive of a great deal of annoyance by the itching and smarting which they occasion, they are not attended by the intense burning pain which characterizes the affection which will next be described, and though they may, like it, cause suffering during the act of defecation, this suffering is of comparatively brief duration. The *treatment* consists in the enforcement of scrupulous cleanliness, and in the application of stimulating and slightly astringent washes or ointments, with attention to the state of the bowels and the administration of arsenic or other alteratives, as indicated by the general condition of the patient. Among the most useful local applications are solutions of nitrate of silver (gr. v–x to f℥j) or borax, the oxide of zinc or tar ointments of the U. S. Pharmacopœia, and the citrine ointment diluted to an eighth of its officinal strength. If mucous patches or vegetations exist, they must be treated as directed in previous chapters (pp. 455, 469, 511).

2. **The True Fissure of the Anus,** or, as it should, in many instances, rather be called, the *Painful Ulcer of the Anus,* is a small ulcer situated at or within the margin of the anus, and in the grasp, as it were, of the sphincter. It appears, when at the margin of the anus, as a linear ulcer or fissure (whence its name), but, when within the gut, may be seen by dilating the sphincter with the speculum to be of an elongated oval shape, rarely exceeding half an inch in length by a quarter of an inch in breadth. The *fissure* is not unfrequently concealed by a small reddish pile or fold of skin, while the *painful ulcer* may be complicated by the existence of a rectal polypus.

Symptoms.—The symptoms of this affection are sufficiently characteristic. The patient experiences an intense burning pain, beginning at the time of or shortly after the act of defecation, and continuing without alleviation for several hours subsequently. The severity of the pain induces the patient to postpone going to stool as long as possible, thus causing an artificial costiveness which only aggravates his condition. The feces themselves may be streaked with blood or pus on the side corresponding to the seat of the ulcer.

There is always a spasmodic contraction of the sphincter ani, attended with tenesmus, and often with a discharge of slimy mucus, and there is frequently great sympathetic disturbance of the urinary apparatus, or of the uterus, occasioning an error in diagnosis by directing attention to these organs. The true nature of the case may, however, always be detected by digital or ocular examination, aided, if necessary, by anæsthesia and the use of the speculum. The fissure or ulcer may occupy any part of the circumference of the anus, but is commonly found posteriorly. This is essentially an affection of adult life, though Houghton, of Dudley, has seen a well-marked case in a child one year old.

Treatment.—In slight cases, a cure may sometimes be effected by the application of chloral, iodoform, or nitrate of silver, and by the use of anodyne and astringent lotions, ointments, or suppositories, but in the majority of instances, at least in adults, a trifling operation will be necessary. Boyer, who first accurately described this affection, divided the whole sphincter, thus effectually putting the part at rest and allowing the ulcer to heal; but this procedure is now known to be unnecessarily severe, and the practice of modern surgeons is simply to divide the floor of the ulcer and the muscular fibres immediately beneath it. The rectum being emptied by an enema, the surgeon introduces upon his left forefinger, which serves as a director, a straight, narrow, probe-pointed knife, and, beginning above the upper margin of the ulcer, cuts quickly downwards, fairly dividing in a longitudinal direction the whole ulcerated surface through its centre. In some cases it may be more convenient to expose the ulcer by means of a fenestrated speculum, the incision being made through the aperture of the instrument. The patient may be etherized for this little operation, if thought necessary, but chloroform should not be used, as death has, according to Ducamp, followed its employment several times in these cases. The after-treatment consists in the application of a little oiled lint and the introduction of an opium suppository.

Récamier, and more recently Van Buren, of New York, have recommended, instead of the incision of the ulcer, forcible dilatation or partial rupture of the sphincter, accomplished by introducing both thumbs, or both forefingers, back to back into the rectum, and then widely separating them. I do not know that this procedure is any less painful than the incision, while it is, I think, less certain to effect a permanent cure.

3. Chronic Ulcer of the Rectum.—Extensive ulceration of the rectum, *above* the sphincter, may result from dysentery, from the irritation caused by foreign bodies or hardened feces, or from the incautious use of bougies or enema-tubes. The symptoms are pain, not, however, usually very severe, with a muco-purulent discharge. The ulcers may be felt by digital examination, or seen by the aid of the speculum. The *treatment* consists in the employment of anodyne and astringent lotions or suppositories, with attention to the state of the digestive functions. Advantage may be sometimes derived from the internal use of the confection of black pepper, which has acquired a reputation under the name of *Ward's paste.*

4. Tuberculous Ulcer of the Anus.—Under this name MM. Martineau and Féreol have described an affection resembling that met with by Trélat in the tongue (see p. 745). They advise the topical use of a weak solution of chloral. Gosselin suggests the application of bismuth. Iodoform has also been recommended.

HEMORRHOIDS.

Hemorrhoids, or *piles*, are tumors met with at or within the verge of the anus, consisting essentially of a hypertrophy and infiltration of the mucous or muco-cutaneous and subjacent areolar tissues, with a varicose dilatation of branches of the hemorrhoidal veins; in some instances rupture of a vein occurs, with extravasation of blood into the subcutaneous tissues, while in other cases there appears to be a new development of arterial capillaries, the pile being then of a vascular, spongy, and almost erectile character, and its mucous covering having an ulcerated, granular, or somewhat villous appearance.

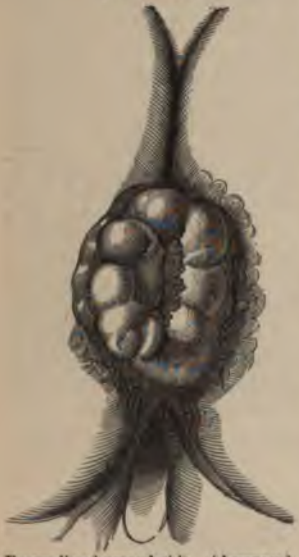
Piles are classified according to their situation, into *external* and *internal*, and, according to the presence or absence of hemorrhage, into *open* or *bleeding*, and *blind* piles. The ordinary *bleeding pile* is that form of internal hemorrhoid in which the arterial element predominates, and is sometimes called from its shape the *globular* pile, in contradistinction to the *longitudinal* or *fleshy* pile, which is rarely attended by hemorrhage.

Causes of Hemorrhoids.—Any circumstance which impedes the returning current from the hemorrhoidal plexus of veins, or which encourages a flow of blood to the rectum, tends to promote the formation of piles; hence a sedentary life, luxurious habits, occupations which require much standing (as that of a barber), disorders of the alimentary canal, or of the liver, the presence of abdominal tumors, the pregnant state, constipation, the straining due to urethral stricture or prostatic enlargement, inordinate sexual indulgence, etc., may all act as causes of hemorrhoids. Piles may occur at any age, but are most common during the periods of adolescence and later adult life. They occur with about equal frequency in either sex. The first step in the formation of a pile, either external or internal, is dilatation of a hemorrhoidal vein, soon followed, if the disease persists, by hypertrophy and infiltration of the superincumbent tissues; when the pile is unirritated or *indolent*, it may appear to consist merely of a fold of skin or mucous membrane and areolar tissue, but when from any cause the hemorrhoid is *inflamed*, it becomes swollen and tense, and is evidently filled with fluid or coagulated blood. After a succession of such attacks, the pile forms a distinct tumor, sometimes of considerable size, which, even in its indolent state, gives a good deal of annoyance by its bulk and the sensation of weight which it occasions.

External Piles.—In the *indolent* state these appear as small tumors or radiating folds, occupying the verge of the anus external to the sphincter, and covered with the thin integument of the part. They give rise to a feeling of heat and fulness about the anus, particularly after defecation, and may be attended with some itching, but do not usually cause a great deal of inconvenience. When *inflamed*, however, they become excessively painful, the pain radiating in various directions and being much aggravated by exercise, or even by the assumption of the erect posture; they are often accompanied by an intolerable itching and burning, with violent tenesmus, depriving the patient of sleep, and for the time being rendering life almost a burden. If examined in this condition—which constitutes an "attack of the piles"—the hemorrhoidal tumors will be found tense and swollen, extending up within the grasp of the sphincter, and thus becoming partially covered with mucous membrane (*extero-internal* piles). Their color, which in the uninflamed state was nearly that of the surrounding integument, is now of a deep purplish-red hue. The hemorrhoidal tumor occasionally suppurates, but more commonly returns gradually to its previous indolent state, becoming, however, larger and more indurated with each successive attack of inflammation. When piles are large and numerous, the skin between them may undergo maceration, giving rise to a sero-purulent discharge which sometimes produces troublesome excoriation. External piles are rarely attended by bleeding, but Syme and others have recorded cases of profuse rectal hemorrhage, in which no internal piles could be found, and in which entire relief was afforded by the removal of the pendulous flaps of skin which surrounded the anus. The *diagnosis* of external piles is made with little difficulty; the only affections with which they are liable to be confounded are *vegetations* and *mucous patches*, but these can be distinguished by observing that they are not, like piles, solely confined to the anal region. External hemorrhoids often coexist with the painful ulcer of the anus, or with fistula in ano.

Internal Piles.—These are situated entirely within the sphincter, and are therefore covered with mucous membrane. As already mentioned, there are two principal varieties, the *longitudinal* or *fleshy* pile, which in structure corresponds pretty closely with the external hemorrhoid, except that the venous element is more prominent, and the *globular*, *vascular*, or *granular* pile, which is characterized by the development of a congeries of arterial capillaries. The former variety has a broad base, is firm and elastic to the touch, and of a reddish-brown color; the latter may be either sessile or pedunculated, is at first of a bluish hue (resembling a varicose vein), but ultimately assumes its characteristic red color, and villous or strawberry-like appearance. Internal piles may exist just within the sphincter, or an inch or two higher up; occasionally the hemorrhoidal tumors form a double circle, one above the other. The symptoms of internal piles are similar to those of external hemorrhoids, but there is more distress, from the tumors frequently protruding during defecation and being caught or grasped by the sphincter, thus causing great pain and tenesmus. The frequent protrusion of the piles ultimately leads to general prolapse of the mucous coat of the rectum, while the constant irritation of the part gives rise to a discharge of thin mucus, which excoriates the skin around the anus, and is often sufficiently abundant to soil the patient's clothes.

FIG. 453.



Protruding hemorrhoids. (ASHTON.)

Bleeding from the Rectum, or the *Hemorrhoidal Flux*, is a most characteristic symptom of internal piles; it may accompany either form of the disease, though by far most common in connection with that in which there are isolated tumors with a granular, strawberry-like surface. In most instances, blood of an arterial hue appears to issue directly from the surface of the pile, but occasionally there is general oozing from the congested mucous membrane, or a copious stream may be poured from an ulcerated opening in a dilated vein. The amount of blood varies, in different cases, from a few drops to many ounces—enough in some instances to produce excessive and even fatal anæmia and exhaustion. The bleeding may be continuous, or intermittent—recurring sometimes at regular intervals. The occurrence of the hemorrhoidal flux is not unfrequently preceded for some days by an increase of the ordinary symptoms of piles, constituting what the older writers called the *Hemorrhoidal Effort:* in these cases, the loss of blood seems often to act beneficially both by giving local relief and by acting as a derivative, and perhaps preventing serious visceral congestions. The hemorrhoidal flux sometimes alternates vicariously with the menstrual flow. The pain in a severe case of internal piles is not limited to the rectum, but radiates to the loins, sacrum, hips, and thighs, and marked sympathetic irritation is frequently developed in the genito-urinary organs. Internal, like external, piles may become inflamed, and ultimately subside into an indolent condition, persisting as hard and incompressible tumors containing clotted blood; the clot occasionally undergoes a calcareous change, and becomes converted into a *phlebolite* or *vein-stone.* In other instances, the piles protrude, and are strangulated by the sphincter, eventually sloughing off, and thus undergoing a spontaneous cure.

Internal hemorrhoids are to be *diagnosticated* from prolapsus, and from polypus of the rectum: in complete prolapse of the rectum (a very rare affection in adults), the smooth character of the mucous membrane and the cylindrical form of the protrusion will enable the surgeon to make the diagnosis, while the common form of prolapse, in which the mucous membrane alone is implicated, may usually be distinguished from piles by its annular form, and by the absence of distinct tumors. The two affections, however, often coexist in the same patient. Rectal polypus may be recognized by its being solitary and of comparatively large size. The *diagnosis of bleeding piles* from other sources of intestinal hemorrhage may be made by observing that the blood in the hemorrhoidal flux is bright, liquid, and spread over, rather than mingled with, the feces, whereas blood entering the bowel at a higher point will be dark, partially clotted, and mingled more or less intimately with the other contents of the intestinal canal. Internal hemorrhoids sometimes exist in cases of fistula in ano, and may prove a troublesome complication in the treatment of that affection, by protruding in the wound after the operation.

Treatment of Hemorrhoids.

Constitutional Treatment.—This consists in endeavoring to improve the general health, by the administration of nutritious food and tonics if the patient be of relaxed or debilitated frame, or by regulating the diet and partially cutting off the supply of animal food under opposite circumstances: highly seasoned dishes and alcoholic stimulants should be particularly avoided. Any habits that predispose to the disease should be given up, and the patient should daily take moderate, but not fatiguing, exercise in the open air. If any special cause of the affection can be detected (as urethral stricture), this must, of course, be appropriately treated. In every case the bowels should be kept in a soluble condition by the administration of mild laxatives, such as castor oil, the compound rhubarb pill, copaiba, the confection of black pepper or senna, the mineral waters of Saratoga or Kissingen, etc. Glycerine, as recommended by G. B. Powell, D. Young, and others, may be employed with advantage. Enemata of cold or tepid water, as most agreeable to the patient, are sometimes of service.

Local Treatment.—The local treatment may be *palliative* or *radical:* the former will, in many instances, suffice to give very great comfort to the patient, and may in mild cases even effect a permanent cure; it is often the only plan which is applicable in the latter stages of pregnancy, or in extreme old age. The radical cure, or that by operation, should, however, usually be advised whenever the hemorrhoidal tumors have become permanent, leading to more or less constant inconvenience and suffering, and particularly in cases of bleeding piles, in which the amount of blood lost tends to render the patient anæmic. If, on the other hand, the hemorrhoidal flux be slight and not productive of much annoyance, it may, in some instances, be wiser not to interfere, for, as already mentioned, there is reason to believe that the loss of blood in these cases sometimes acts beneficially as a derivative.

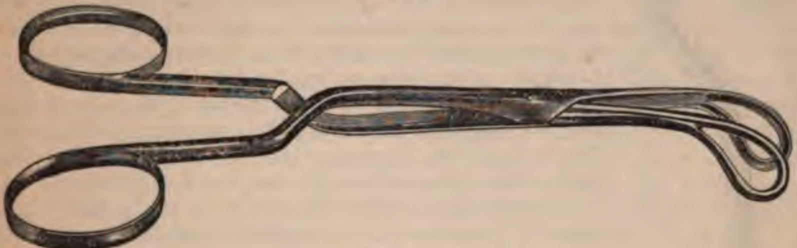
The Palliative Treatment consists in the topical use of various astringents and anodynes, and in the practice of frequent ablutions, so as to insure perfect cleanliness. Sponging with cold water, or the employment of the cold douche, should be resorted to night and morning, and after each fecal evacuation. For *internal* piles, weak astringent injections (as of alum, or of the Tinct. ferri chloridi, ten drops to the ounce) may be applied, and are particularly useful in cases complicated with prolapsus. Enemata of the fluid extract of ergot (fʒss to f℥ss of water) are highly recommended in these cases by Dr. Semple, of Virginia, and Drs. Orr and Conner, of Cincinnati, while Langenbeck advises the injection of ergotin beneath the rectal mucous membrane. Enemata of bismuth (in the form of the liquor bismuthi) are recommended by Dr. Cleland. Whenever the piles protrude, they should be carefully replaced. In other cases, great comfort may be derived from the use of opium combined with acetate of lead or tannic acid, in the form of suppositories. The same or similar remedies may be used for *external* piles, in the form of ointments. A good combination is one containing equal parts of the gall and stramonium ointments of the U. S. Pharmacopœia. To relieve the itching which attends either form of piles, the best remedy, according to my experience, is the Ung. hydrargyri nitratis, diluted in the proportion of one part to seven. When piles become inflamed, the patient should be put to bed and the part constantly fomented or poulticed, while the bowels are moved with mild laxatives. Leeches may sometimes be applied around, but not over, the hemorrhoidal tumors, and if a pile be tense and evidently filled with coagulated blood, a puncture may be made with a lancet or sharp bistoury, and the clot turned out. An ice-bag may be substituted for the warm applications, if more agreeable to the patient. Forcible dilatation of the sphincter ani is recommended by Verneuil, Fontan, and Cristofori. As a rule, no operative treatment should be instituted while the piles are in a state of inflammation, though, as the operation can be rendered painless by anæsthesia, it need not be postponed if there be any reason to the contrary.

The Radical or Operative Treatment of Hemorrhoids may consist in excision, ligation, torsion, the application of caustics or the cautery, or the injection of coagulating fluids.

1. **Excision** is chiefly adapted to the treatment of *external piles*. For the removal of these, it is sufficient to seize each pile with broad-bladed ring-forceps (Fig. 454), and cut it off with scissors curved upon the flat, treating in the same way any loose folds of skin that may exist around the anus. If the piles be altogether external (covered with skin only), there is no risk of troublesome hemorrhage, and any bleeding that may occur can be readily controlled by pressure or torsion. If, however, as is often the case, the piles

be partly covered with mucous membrane (*extero-internal*), the hemorrhage may be quite profuse, and it is then much better to use the ligature in the way which will be presently described, notching first with the scissors the cutaneous surface of the hemorrhoidal tumor, and applying the ligature in the groove thus made. Care must be taken, in the excision of external piles, not to remove too much skin, lest the contraction which occurs in the healing process should result in the formation of a troublesome anal stricture.

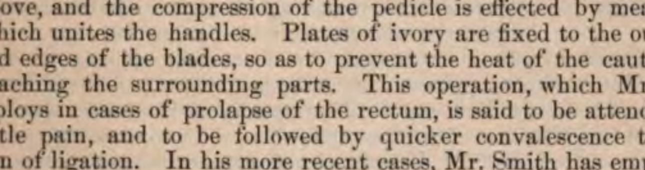
FIG. 454.



Ring-forceps for piles.

In order to render excision a safe mode of treatment for *internal piles*, a plan which originated with Cusack, of Dublin, may be employed. In this, which is called the *Operation by Clamp and Cautery*, the base of the hemorrhoidal tumor is closely compressed between the blades of clamp-forceps, and, the pile being then cut off with scissors, bleeding is prevented by applying to the stump or pedicle strong nitric acid or the hot iron. Instruments for this operation have been devised by H. Lee, Wood, and others, the best, probably, being that introduced by H. Smith, of King's College Hospital. The blades of this apparatus (Fig. 455) fit accurately together with a tongue and groove, and the compression of the pedicle is effected by means of a screw which unites the handles. Plates of ivory are fixed to the outer surfaces and edges of the blades, so as to prevent the heat of the cautery-iron from reaching the surrounding parts. This operation, which Mr. Smith also employs in cases of prolapse of the rectum, is said to be attended with very little pain, and to be followed by quicker convalescence than the operation of ligation. In his more recent cases, Mr. Smith has employed a cautery with a cutting or a serrated edge, thus removing and cauterizing the hemorrhoid at the same time, and dispensing with the use of scissors.

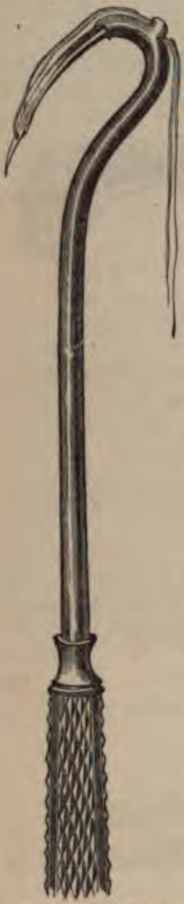
FIG. 455.



Smith's clamp for piles.

2. Ligation is the method usually employed for the treatment of *internal piles*, and it is that which I myself am in the habit of adopting. The patient should take a dose of castor oil the night before, and have his lower bowel thoroughly washed out by means of an enema on the morning of the operation. Though it is not absolutely necessary, it is usually better for him to be etherized. If the piles do not protrude, they may be made to do so by administering a warm water enema, which will bring them down as it is ejected from the rectum; or, if the patient is etherized, they may be brought down with the finger.

FIG. 456.



Bushe's needle and needle carrier.

The patient being placed on his side and turned slightly over on his belly, while the nates are widely separated by an assistant, the surgeon seizes each tumor with the ring-forceps and transfixes its base with a double ligature, introduced by means of a nævus-needle, or, which is better for the purpose, the needle known as Bushe's (Fig. 456). The needle being detached, the pile is effectually strangulated by tying the ligatures on either side. The ends of the ligatures are then cut short, when the bulk of the strangulated pile may be lessened by cutting off its summit at a safe distance from the point of ligation. If, however, the hemorrhoid arise from some distance up the rectum, it is safer not to use the scissors, but to push the whole strangulated mass above the sphincter. When all the internal piles have been thus ligated, and any external ones that may exist excised, the sphincter should be stretched by introducing both thumbs and pressing them in opposite directions, an opium suppository should be placed in the rectum, and the patient returned to bed, with cold water dressing constantly applied to the anus. The bowels should be kept locked up for six or seven days, after which a free evacuation may be secured by the administration of castor oil. The ligatures become detached usually within a week, leaving small granulating surfaces, which soon heal under the occasional application of nitrate of silver. The operation is sometimes followed by strangury, or even by retention of urine, requiring the administration of a warm bath, or possibly the use of the catheter. In cases of internal piles complicated with prolapsus, the *écraseur* may be occasionally used with advantage, as it produces more contraction than the ligature. The instrument should be very slowly worked, as otherwise its employment is apt to be followed by hemorrhage. Dr. Nott has employed with success a form of clamp which he calls a *recti-linear écraseur*, to compress the base of the pile, then removing the instrument and applying a ligature in the groove which it has left.

The ligation of piles is not entirely free from danger, being, in some cases, followed by erysipelas, pyæmia, phlebitis, or tetanus. I have, fortunately, never as yet seen a fatal result from the operation in my own practice, though I nearly lost one case from erysipelas. In two cases, however, which occurred at the Episcopal Hospital, in the wards of my colleagues, some years ago, tetanus ensued, with a fatal termination.

3. **Torsion** is recommended by Allingham for small and particularly for single hemorrhoids, situated near the median line; the base of the pile is grasped with a clamp applied in a longitudinal direction, and the strangulated mass then seized with broad forceps and slowly twisted off. This mode of treatment is said to be almost painless, but, I confess, seems to me

less safe, and therefore less desirable, than the application of a ligature. The same may be said of the operation with *tooth-edged scissors* suggested by Richardson, of Dublin, and that with *clamp-forceps* advised by Pollock and Benham. Whitehead, of Manchester, employs a combination of torsion with excision, separating the pile except at its point of vascular connection, and twisting through this with forceps.

4. **The Application of Caustic** is particularly suited for those piles in which the arterial element is predominant, and which may be recognized by their granular or strawberry-like appearance. This mode of treatment, which was introduced by Houston, of Dublin, is now chiefly advocated by H. Lee, Fergusson, and H. Smith; it is more apt to succeed when the piles are sessile than when they are pedunculated. The caustic used is strong *nitric acid*, which is conveniently applied with a piece of wood or a glass brush through a fenestrated glass speculum; as soon as the pile is well coated with the acid, it should be wiped with a piece of lint dipped in oil, or in a paste of prepared chalk and water. A thin slough is formed, the detachment of which leaves a healthy granulating surface which soon heals. The great advantage of this mode of treatment is, according to H. Smith, that it does not require the patient to keep the house after the operation. If the acid be carefully applied, so as not to touch the skin, it causes very little pain; but its use is not absolutely free from risk, one case referred to by Erichsen having terminated fatally from erysipelas.

5. **Puncture** of the pile with the conical tip of Paquelin's **Gas Cautery** is recommended by H. A. Reeves, and by Gosselin.

6. **The Injection of the Tincture of Chloride of Iron** has been successfully resorted to, in the treatment of internal piles, by Colles, of Dublin. The instrument used is the ordinary hypodermic syringe, and about 20 minims of the tincture are injected into each hemorrhoid. The operation is said to be painless, but I should fear would expose the patient to the risk of embolism. Carbolic acid has been employed in the same way by Drs. J. H. Pooley, E. Andrews, and other surgeons.

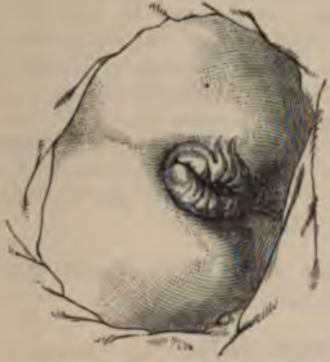
Prolapsus of the Rectum.

This occurs under two forms—the *partial* and the *complete*. In *partial prolapsus* of the rectum, the mucous membrane of the gut is alone involved in the protrusion, though the submucous areolar tissue is commonly thickened and elongated. In *complete prolapsus*, all the tissues of the gut are involved, the bowel being actually invaginated, and protruding sometimes to the extent of several inches.

Causes.—The *causes* of prolapse of the rectum are, (1) a relaxed and weakened state of the tissues in general, such as is met with in feeble children or in debilitated adults; (2) chronic irritation of the rectal mucous membrane, such as results from dysentery or from the presence of internal piles; and (3) reflected irritation dependent upon diseases of other organs, such as urethral stricture, prostatic enlargement, vesical calculus, or exstrophy of the bladder.

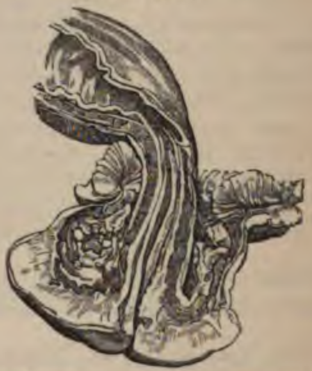
Symptoms.—The protrusion occurs, at first, only after defecation, and perhaps only when the bowels are unduly relaxed; but as the disease progresses, the prolapse becomes more constant, coming down when the patient stands or walks, and being with difficulty kept in place. In the *partial* form of prolapse the mucous membrane forms a red or purplish ring, somewhat elongated in shape, and continuous with the mucous coating of the sphincter; in the *complete* prolapse the gut is invaginated through the sphincter, between which and the protruded bowel a distinct groove may always be recognized. The complete prolapse forms an elongated cylindrical tumor, of the ordinary color of mucous membrane, presenting a smooth and even surface in the child, but being usually somewhat convoluted and rugose in the adult. When the protrusion is down, there is a sensation of weight and dragging, with some pain (not, however, very intense), and sympathetic vesical disturbance. In a case of recent prolapsus of either form, strangulation may occur, leading perhaps to sloughing, and possibly spontaneous cure; but in cases of long standing the sphincter is commonly much relaxed, facilitating both the descent and the reduction of the protrusion. According to Lannelongue, infantile prolapsus is not an unfrequent cause of rectal stricture in later life.

FIG. 457.



Partial prolapsus of rectum. (BRYANT.)

FIG. 458.



Section of complete prolapsus of rectum. (DRUITT.)

Diagnosis.—The diagnosis of prolapsus of the rectum is usually made without difficulty; the complete form of the affection can, indeed, scarcely be mistaken for anything else, while partial prolapse is only likely to be confounded with internal piles, with which it is very often complicated, but from which it may be distinguished by the annular character of the protrusion, and by the absence of distinct tumors. Mr. Stocks has reported a case in which an ovarian cyst protruded through the anus, and was at first mistaken for prolapsus of the rectum.

Treatment.—The first step in the treatment of prolapse of the rectum is to effect reduction; this may usually be readily effected by placing the patient on his side, and gently but firmly compressing and pushing up the gut with the hand, protected with a soft cloth dipped in oil. If the sphincter be much dilated, both hands may be required—one to fix the part, while compression is made with the other. When strangulation occurs, reduction may be, if necessary, facilitated by incising the mucous membrane, if the prolapse be of the partial variety, or by dividing the sphincter, if complete invagination have occurred. After reduction, the part may be supported with a pad and bandage. In order to prevent a recurrence of the prolapse, the bowels should be kept in a soluble condition by the administration of laxatives, such as were recommended for piles. The descent of the gut while at stool should be prevented by avoiding straining, and by having the bowels moved while in the recumbent position, or even while standing—protrusion being less apt to occur in either of these than in the ordinary sitting posture. With children a *kneeling* posture is preferable, and the nurse may, as advised by MacCormac and H. Smith, be directed to draw the skin of the anus forcibly to one side during the act of defecation, so as to cause contraction of the sphincter, and thus prevent the gut from protruding. In mild cases, a cure may often be obtained by attention to these points, and by the local use of bismuth or other astringents in the form of injections or suppositories. Hypodermic injections of *strychnia* are advised by Lorigiola, W. H. Thomson, and L. Weber, and those of *ergotine* by Langenbeck, Henoch, and Vidal. The daily use of the cold douche is highly recommended by Saint Germain. If the prolapse be due to sympathetic irritation from stricture, calculus, etc., these affections must, of course, be properly treated, when the rectal complication will commonly subside of itself.

Operative Treatment.—In cases of extensive and inveterate prolapsus, especially in adults, something more may be required. *Excision* of the muco-cutaneous folds around the anus, *ligation* of two or more folds of mucous membrane, the application of *caustics*, and the operation by *clamp and cautery*, are the chief modes of treatment.

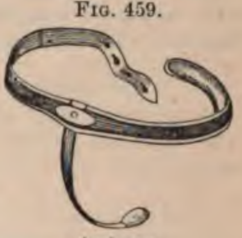
1. *Excision* is effected simply by cutting off with curved scissors the radiating flaps of integument around the anal orifice, the subsequent contraction often sufficing to effect a cure; if the incision involve the mucous membrane, a stitch or two should be inserted so as to guard against hemorrhage.

2. *Ligation* is effected by seizing with ring-forceps a portion of the prolapsed mucous membrane, and tying it firmly with a *single* ligature: it is usually sufficient to apply one ligature on either side, but more may be required if the prolapse be extensive. The parts should then be carefully returned through the sphincter, and an opium suppository introduced.

3. *Caustic*, the strong nitric acid being the best, may be applied, through a fenestrated speculum, as directed in the case of piles, or to the protruded gut, before reduction, as advised by Allingham.

4. The *Clamp and Cautery* method is perhaps the best mode of treatment. Longitudinal folds of mucous membrane are to be seized with Smith's clamp and cut off with scissors, the pedicle being then seared with a hot iron.

FIG. 459.



Anal truss.

5. *Excision of a* V*-shaped Segment* of the sphincter on one or both sides has been occasionally practised, but is a severe mode of treatment, and may be followed by fecal incontinence.

Finally, in cases in which operative interference is not deemed advisable, great comfort may be afforded by the adaptation of a well-fitting anal truss or supporter, such as is shown in Fig. 459.

INFLAMMATION OF THE RECTAL POUCHES.

The pouches or lacunæ of the rectum are sometimes much enlarged, chiefly in old people, becoming distended with fecal matter, and, as a consequence, inflamed or ulcerated, and causing intense itching, and often severe pain, unaccompanied, however, by spasm of the sphincter. This affection was first described by Physick, under the name of *Encysted Rectum*, and is called by Gross *Sacciform Disease of the Anus.* The *diagnosis* is readily made by exploring the rectum with a blunt hook or a probe bent at its end. The *treatment* consists in drawing down successively each pouch that is affected, and excising the mucous fold at its base with curved scissors.

Neuralgia of the Anus.

This usually occurs as a symptom of some local lesion (as painful ulcer of the rectum), but may exist independently. The *treatment* in such cases is very unsatisfactory; the free use of quinia and the local application of belladonna are perhaps the best remedies.

Pruritus or Itching of the Anus.

This is probably always symptomatic, but occasions so much distress as to be worthy of special mention. It may be due to hemorrhoids, to the presence of intestinal parasites, to papular or other eruptions in the neighborhood of the anus, or to uterine displacement. The treatment consists in the removal of the cause, if this can be ascertained, in attention to the state of the bowels, in the use of frequent ablutions, and in the employment (somewhat empirically, it must be confessed) of various washes or ointments. The dilute citrine ointment is, perhaps, the best remedy for itching piles, while for the pruritus dependent on cutaneous eruptions of the part, the tar and iodide of sulphur ointments of the U. S. Pharmacopœia will often be found useful. Curling speaks highly of an ointment containing chloroform and oxide of zinc, and a wash of sulphuret of potassium and lime-water (ʒj–f℥viij). Chlorinated lotions or weak solutions of hydrocyanic acid may also be employed, or a weak solution of carbolic acid (gr. v–f℥j). Camphor, chloral, and various preparations of mercury have also been advantageously used as topical applications. Arsenic is often of service as an internal remedy, and may be conveniently given in the form of arsenious acid, combined in a pill with iron and quinia.

CHAPTER XLIII.

DISEASES OF THE ABDOMINAL ORGANS, AND VARIOUS OPERATIONS ON THE ABDOMEN.

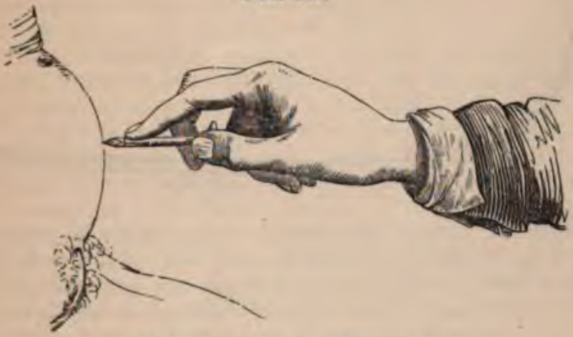
Paracentesis Abdominis.

Paracentesis abdominis, or "the operation of tapping," is not unfrequently required in cases of ascites and ovarian dropsy. The circumstances which in any particular case indicate or contra-indicate this operation, are discussed in works on the Practice of Medicine or on the Diseases Peculiar to Women, and it will, therefore, only be necessary to describe in these pages the manual procedure itself.

The bladder having been emptied, the patient sits on the edge of the bed, or lies on either side, a broad four-tailed flannel bandage being laid over the upper part of the abdomen, and the ends crossed behind, and firmly held by an assistant. The surgeon makes a short incision in the median line about an inch and a half below the umbilicus, dividing the superficial structures, and then with a quick motion thrusts in a full-sized trocar and canula; the trocar being withdrawn, the fluid is allowed to escape, and is collected in suitable basins or pails. While the flow continues, the bandage should be continually tightened, so as to compress the abdomen and prevent the occurrence of syncope. Should the canula become clogged, it may be freed from obstruction by introducing a director or flexible catheter. When all the fluid has been evacuated, the canula is withdrawn and the wound closed with a broad adhesive strip, the abdomen being supported with a firm compress and bandage.

The steps of the operation as above described may be occasionally varied; thus, if the abdominal parietes be tense and thin, the trocar may be thrust in at once, without a preliminary incision, the instrument being hindered from penetrating too far by the operator's finger placed about half an inch from the point, while the canula may, if preferred, be provided with a stopcock and flexible tube, as in the operation of paracentesis thoracis. The puncture in the median line is to be adopted in cases of ascites, and indeed in every instance, unless the unilateral character of the swelling should indicate the choice of another locality, when the puncture may be made in the corresponding linea semilunaris. When, as usually happens, the operation has to be repeated, the second puncture should be made a few lines above or below the cicatrix of the first.

Fig. 460.



Tapping the abdomen. (Fergusson.)

The operation of tapping is rarely attended by any unpleasant results; it may occasionally, however, be followed by the development of a low form of peritonitis, and, in cases of dropsy from malignant disease, the wound of puncture may become the seat of secondary deposits.

It might seem unnecessary to caution the surgeon against mistaking pregnancy for abdominal or ovarian dropsy, but for the fact that tapping has occasionally been incautiously employed under such circumstances, with an unfortunate result that can be readily imagined.

Ovarian Tumors.

I do not purpose entering into any prolonged discussion of the symptoms, diagnosis, and therapeutics of ovarian disease, for these subjects belong more to the special domain of Gynæcology than to that of Surgery; it will be sufficient to enumerate the principal affections with which ovarian tumors are likely to be confounded, and to describe briefly the various operative procedures which are employed in their treatment.[1]

Diagnosis.—*Fecal Accumulations* in the cæcum or other parts of the large intestine have been mistaken for ovarian tumors; the diagnosis may commonly be made by digital examination *per vaginam*, the fecal tumor imparting a characteristic doughy sensation to the touch.

Pregnancy, either normal or extra-uterine, is usually attended with such obvious symptoms as to prevent the possibility of mistake, and in any case of doubt, a brief delay will serve to clear up the diagnosis.

Fibro-muscular Tumors of the Uterus can usually be distinguished from ovarian growths, by observing that in cases of the former there is commonly uterine hemorrhage and leucorrhœa; the uterine sound or probe enters further than in the normal state; the tumor, which is often multiple, is usually hard, and by vaginal exploration is found to be irregular in outline and continuous with the uterus; and, finally, if the uterus be moved by means of the sound, the tumor moves with it. On the other hand, in a case of ovarian tumor, there is neither menorrhagia nor leucorrhœa; the uterine sound enters only to the normal distance; the tumor, which is usually solitary, often fluctuates, and is smooth and not continuous with the uterus; and, finally, the uterus can be moved without the tumor moving with it. It is to be noted, with regard to the last diagnostic point, that it is the *uterus* and not the *tumor* which must be movable; for the upper part of a solid uterine growth may be movable, while its base is so tightly wedged in the superior strait of the pelvis that no motion can be communicated to the mass through the uterine sound.

Fig. 461.

Sims's uterine probe, smallest size.

Ascites can commonly be distinguished by the character of the tumefaction, which in abdominal dropsy is uniform, but in ovarian disease is localized at first to one or other iliac fossa; by the flattening of the abdomen, in the recumbent posture, owing to the ascitic fluid gravitating to the sides of the peritoneal cavity; by the change in the line of dulness upon variation in the patient's position; by the resonance anteriorly when the patient lies on her back, owing to the intestines floating upward; by the prominence of the recto-vesical pouch, in which fluctuation can be detected by the finger introduced into the vagina; by the presence of a distinct wave when the patient rolls in bed; and by the coexistence of signs of disease of the heart, liver, or kidney, the skin being often harsh and jaundiced, and the feet œdematous at an early period of the affection. In dropsy from disease of the ovary, on the other hand, beside the local character of the swelling in the early stages, it is found that, owing to the fact of the fluid being contained in a tense cyst, there is no flattening of the abdomen nor anterior resonance in the supine posture; little or no variation in the line of dulness; no prominence of Douglas's cul-de-sac; no abdominal wave when the patient rolls in bed; and no evidence (except by a coincidence) of disease of other viscera. Finally, in a doubtful case, the diagnosis may be made by examining the fluid withdrawn by tapping, which, if the disease be ovarian, will probably be found to contain altered blood-cells, epithelial scales, masses of granular matter, oil globules, and crystals of cholestearine. Hughes-Bennett, and, more recently, Dr. Drysdale, of this city, have described cell-forms which they believe to be peculiar to ovarian fluids, but their views have not been universally accepted by pathologists. Foulis and Knowsley Thornton have described certain groups of cells as being peculiar to the fluid from malignant growths of the ovary or peritoneum. According to Spiegelberg, if the ovarian fluid be of low density and of a serous character, the cyst-wall has ceased to grow actively, and simple tapping may be advantageously substituted for ovariotomy.

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[1] In the following pages I have drawn freely from Prof. T. Gaillard Thomas's excellent "Practical Treatise on the Diseases of Women."

Cystic Disease of the Broad Ligament so closely resembles that of the ovary, that a diagnosis is frequently impossible, though if the fluid removed by tapping were found to be non-albuminous and like that of ascites, there would be strong reason for believing that the ovary was not implicated.

The fluid from *Fibro-cystic Tumors of the Uterus* is, according to Atlee and other authorities, remarkably free from morphological elements, while it coagulates spontaneously and completely. Drysdale describes a peculiar cell which he believes to be characteristic of this form of tumor.

Other abnormal conditions may be occasionally mistaken for ovarian tumors, such as *hydatids, uterine distension from retention of the menstrual secretion, accumulation of fat in the omentum or abdominal walls, partial contractions of the recti muscles, hydronephrosis,* and *cysts of the kidney or spleen.*

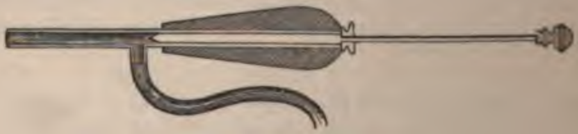
Though the diagnosis of ovarian tumors can, in most instances, be made with tolerable certainty, by careful and repeated examination, yet cases occasionally occur which completely baffle the most cautious observer, and it has repeatedly happened that the operation of ovariotomy has been undertaken in cases in which no ovarian tumor could be found, the morbid growth being perhaps connected with the uterus, kidney, spleen, or omentum; or more rarely there being no tumor at all (see *Phantom Tumor*, p. 490). The difficulty, and in some cases impossibility, of making a correct diagnosis, is one of the strongest arguments against the propriety of ovariotomy; and yet the operation should not on this account be considered unjustifiable, more than should the ligation of arteries for aneurism, on the ground that deligation has been occasionally performed when no aneurism existed.

Treatment.—*Solid tumors* of the ovary do not, as a rule, call for operative interference, and the same may be said of those tumors which contain both *solid and fluid* elements, with the exception of the fibro-cystic tumor, or cystic sarcoma, which occasionally may properly be removed by ovariotomy. Hence the remarks which follow are to be understood as applying to the treatment of *cysts* of the ovary, which are of much commoner occurrence than the other forms of tumor. The question whether or not a tumor of the ovary be cystic, can usually though not invariably be decided by noting the presence or absence of fluctuation, upon external, and especially upon vaginal, palpation. In any case of doubt, an exploratory puncture with a small trocar should be resorted to. There may be a *single* cyst, or the tumor may be *multilocular;* in the latter case the secondary cysts may sometimes be recognized by palpation, and the contained fluid is usually darker and more viscid than that of a cyst which is unilocular; single cysts, moreover, rarely attain a very large size; the distinction is of importance as regards the prognosis of the case, single cysts being occasionally curable by milder measures than ovariotomy, and offering a better prospect of recovery after that operation, than multilocular growths. Another point which is usually considered of great importance as regards the prognosis of ovariotomy, is the presence or absence of adhesions; these may sometimes be detected by careful palpation and auscultation, but, on the other hand, may exist without giving any evidence of their presence; it is probable, however, that, as remarked by Spencer Wells, the prognosis after operation is more influenced by the age and general condition of the patient than by the size and condition of the tumor. According to this writer, the prognosis is more favorable in patients under twenty or over sixty years of age, than in those at an intermediate period of life. The existence of *pelvic* adhesions is more to be dreaded than that of adhesions to the omentum or abdominal parietes. The occurrence of *suppuration* in an ovarian cyst is, according to T. Keith, an indication for immediate ovariotomy, and this surgeon reports twelve cases operated on under these circumstances with ten recoveries.

The surgical procedures resorted to in the treatment of ovarian cysts, are *tapping, drainage, incision, partial excision, injection of iodine, galvano-puncture,* and *ovariotomy.*

1. Tapping, the mode of performing which has already been described, is chiefly resorted to as an aid to diagnosis, or with a view to palliation, rather than radical cure. It has been conclusively shown by Spencer Wells, whose experience in cases of ovarian disease is probably greater than that of any other living surgeon, that the prospect of recovery after ovariotomy is not lessened by the fact of the patient having been previously tapped once or oftener; and hence there need be no hesitation in employing this simple operation, either to assist the diagnosis in a doubtful case, or as a means of affording temporary relief before resorting to graver measures. Special care must be taken to prevent the escape of the cystic contents into the peritoneal cavity (an occurrence which might be followed by peritonitis), by using Thomson's "siphon trocar," an aspirator, or some similar instrument. Though in the large majority of instances tapping acts only as a palliative, it has occasionally been followed by permanent recovery; an additional argument in favor of the practice which has been recommended. According to Spiegelberg, this result is most apt to follow when the ovarian fluid is of low density and of a serous character. *Tapping through the vagina or rectum* is occasionally preferred to the ordinary operation through the abdominal parietes.

FIG. 462.



Siphon trocar.

2. **Drainage** is effected by enlarging the puncture made in parietal or vaginal paracentesis, and introducing a tube which is fixed so as to allow the escape of fluid, and, if necessary, the washing out of the cyst with simple or medicated injections. This mode of treatment is chiefly adapted to cases of unilocular cyst, in which ovariotomy is contra-indicated by the extent of adhesions. A more frequent resort to this method has lately been ably advocated by Dr. Stimson, of New York.

3. **Incision** consists in laying open the tumor through the abdominal wall or vagina; this plan, which may be considered a modification of that last mentioned, is best adapted for the treatment of firmly adherent multilocular cysts, which do not admit of ovariotomy on the one hand, nor of simple drainage on the other. Bernutz advises *incision* as preferable to ovariotomy in cases of suppurating dermoid cyst.

4. **Partial Excision** consists in cutting away a small portion of the anterior wall of the cyst, and allowing the contents to escape into the peritoneal cavity; this mode of treatment is more applicable to cases of cystic disease of the broad ligament than to those in which the ovary is involved (see p. 865).

5. **Injection of Iodine** for the cure of ovarian cysts, appears to have been first successfully employed by Dr. Alison, of Indiana, in 1846, but was not brought prominently before the profession until some years afterwards, through the writings of Boinet and other European surgeons. The formula recommended by Boinet is 100 parts each of tincture of iodine and water, with 4 parts of iodide of potassium. The operation consists in introducing through the canula (after tapping) a flexible catheter, by means of which from four to ten ounces of the solution are injected, the liquid being withdrawn again after ten or fifteen minutes; the catheter is retained as long as may be thought necessary, the injections, the strength of which is gradually increased, being occasionally repeated. This mode of treatment should, according to Peaslee, be reserved for cases of unilocular cyst, with clear, serous contents, in which simple tapping has been previously employed at least once; by so limiting its application, Dr. Peaslee believes that the mortality of the operation would be reduced to one in ten, and the proportion of cures increased to one in three.

6. **Galvano-puncture** is recommended by Semeleder, who reports three recoveries by this mode of treatment.

7. **Ovariotomy,** or the formal extirpation of a diseased ovary, was suggested by Wm. Hunter and recommended by John Bell; but the first surgeon who actually resorted to the operation was McDowell, of Kentucky, who performed the first ovariotomy in the year 1809. This case was successful, the patient surviving thirty-two years. McDowell repeated the operation about a dozen times, with varying success, and his example was followed by a few surgeons at home and abroad, but for many years the feeling of the profession at large was that ovariotomy was an unjustifiable procedure, and it is within a comparatively short period only that this operation has been generally accepted as a legitimate resource of surgery. Among those who have acquired most distinction as ovariotomists may be particularly mentioned Bird, Clay, Baker Brown, Tyler Smith, Wells, Thornton, Tait, Bantock, and Keith, among British surgeons; W. L. and

J. L. Atlee, Kimball, Dunlap, Peaslee, Thomas, and Goodell, in our own country, and Koeberle, in France.

The operation is not usually very difficult, but is always one of considerable gravity, the mortality in the hands of the most skilful ovariotomists averaging from about 14 to 25 per cent.[1] This is in itself no valid objection to the operation, for the death-rate is less than that of many other operations which are universally recognized as legitimate; but it is surely sufficient to render the surgeon very cautious in his prognosis, and to induce him to neglect no means of satisfying himself both as to the accuracy of his diagnosis, and as to the applicability of the operation to the particular case with which he has to deal. As Spencer Wells justly remarks, "it is seldom that a surgeon is called upon to perform ovariotomy in order to save a patient from imminent death. . . . . There is generally as much time for discussion as in the parallel case of lithotomy in the male adult. And in both cases, the responsibility of operating, with the full knowledge that if the patient be not saved by the operation he or she is killed by it, must be fairly faced." This responsibility, moreover, is one which the surgeon has no right to throw upon the patient; every woman knows that, after an operation like ovariotomy, she may die or she may get well, and it is to the superior knowledge and wide experience of the surgeon that she looks for advice as to whether the operation is or is not desirable in her particular case. The ultimate decision in this, as in every other case, must of course rest with the patient, but the surgeon should honestly and plainly express his opinion, whether it be favorable or unfavorable; and if, after a full and careful consideration of all the circumstances of the case, he is brought to the conclusion that the operation is, upon the whole, not advisable, he should, in my judgment simply decline to operate.

The *Operation of Ovariotomy* may be performed as follows: The patient's bowels should have been emptied by the administration of a dose of castor oil a day or two previously, and by means of an enema on the morning appointed for the operation. The temperature of the room should be at least 70° Fahr., and the table well covered with blankets; the patient should be thoroughly anæsthetized, and at the last moment the contents of the bladder should be evacuated by means of the catheter.

The first incision is made to correspond as nearly as possible to the position of the linea alba, and may reach from about an inch or an inch and a half below the umbilicus to within two inches of the pubes, though, in many instances, a smaller wound may be sufficient. Wells's statistics, however, go to show that provided that the incision does not extend above the umbilicus, its exact length in inches does not affect the result of the operation. The dissection is cautiously continued until the peritoneum is reached, when, all hemorrhage having been checked, this membrane is opened by picking it up with forceps, making a small cut, and then introducing the left forefinger, upon which as a director the wound is enlarged to the full extent of the external incision. A small quantity of serum now usually makes its escape, when the cyst wall probably presents itself immediately below the wound; should a fold of omentum or a loop of intestine intervene, these should be carefully lifted off and put to one side.

The surgeon then proceeds to investigate the extent of adhesions, if there be any, by introducing first two or three fingers dipped in lukewarm "artificial serum," then a curved steel sound dipped in the same, so as to sweep around the base of the tumor, and finally, if necessary, the whole hand. The "artificial serum," the use of which was suggested by Dr. Peaslee, consists of half an ounce of table-salt, six drachms of white of egg, and two quarts of water. If the adhesions be extensive,[1] or if the tumor be now ascertained to be chiefly or entirely solid, it may be necessary to carry the incision *above* the umbilicus—this being done by a curve to the *left* side, so as to avoid wounding the round ligament of the liver. Should the adhesions be found so firm and extensive as to forbid the hope of removing the tumor, the surgeon may attempt the treatment by drainage, incision, partial excision, or injection of iodine, according to the character of the cyst—whether single or multilocular—and the nature of its contents, which may be ascertained by making an exploratory puncture with a small trocar. (See pp. 865, 866, 867.) If the adhesions be less firm and extensive, those which are accessible may be carefully separated by the fingers, thus completing what may be called the second stage of the operation.

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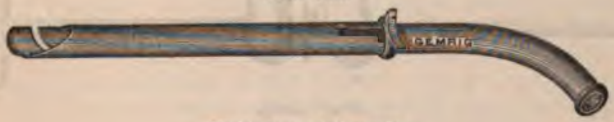
[1] Spencer Wells has published records of 1000 cases, of which 231 proved fatal.

The third stage consists in turning the patient on her side, and then lessening the size of the tumor by tapping the cyst, or the principal cysts, if there be more than one—good instruments for the purpose being the winged trocar and canula of Spencer Wells, or the ingenious hollow trocars devised by Dr. Mears and Dr. Hodge, of this city, and Dr. Fitch, of New Brunswick (Fig. 463). The fluid may be conveyed away through a flexible tube, while the cyst-wall is held forwards with vulsellum forceps, and compression of the abdomen kept up by the hands of an assistant. The sac having been sufficiently reduced in size, is now gently drawn out through the external wound, any remaining adhesions being severed by the hand, by a small cautery iron (or the galvanic cautery), by an *écraseur*, or by scissors, according to the peculiar circumstances of the case. If any hemorrhage occur, it may be controlled by torsion, by styptics, by the cautery, or by the ligature; in the latter case silver wire may be used, or, which is found to answer equally well, the antiseptic ligature of Prof. Lister. If the adhesions be inseparable, it may be necessary to leave a portion of the cyst-wall, which J. L. Atlee advises should then be secured with the clamp, the abdominal wound being carefully closed below the instrument.

FIG. 463.



Fitch's trocar and canula.

The next step is to *secure the pedicle* of the tumor, so as to prevent hemorrhage. This may be done by means of the ligature or the clamp; by dividing the pedicle with the *écraseur* or the actual cautery; by applying torsion to each individual vessel as it is cut across; or by *enucleating*[2] the tumor in the ingenious way recommended by Miner, of Buffalo, so as to avoid hemorrhage by tearing across the vessels at their peripheral terminations. If sufficiently long, the pedicle should be fixed between the lips of the wound, but if too short for this, it must be returned into the abdominal cavity; or it may be "pocketed" in the deeper part of the incision (as suggested by Storer, of Boston), the external wound being accurately closed above it. When the stump is to be fixed in the external wound, the use of the *clamp* is probably the best method of securing the pedicle. Several varieties of clamp have been employed, those devised by Wells, Koeberle, Atlee, and Dawson being perhaps the best. When the stump is so short as to render its restoration to the abdominal cavity necessary, a different plan must be adopted; here the surgeon may choose between slow division of the pedicle and the application of torsion to each separate vessel, the use of the actual cautery, and the employment of the ligature. *Torsion* has not been resorted to sufficiently often to allow a positive opinion as to its merits. If the *ligature* be employed, the pedicle is transfixed and tied in two parts, when the ends may be brought out at the lower end of the wound (Clay's method), or may be cut short and dropped into the peritoneal cavity, as advised by Tyler Smith and Peaslee; if the short cut ligature be used, it should be of silver wire, as advised by Sims, or rendered antiseptic in the way recommended by Prof. Lister. Hayes, of Dublin, recommends the use of a catgut ligature applied subperitoneally, so as to close the vessels without endangering the vitality of the stump. If the *cautery* be used (as was done by Baker Brown), the surrounding parts may be protected by the use of the clamp-shield devised by Prof. Storer.

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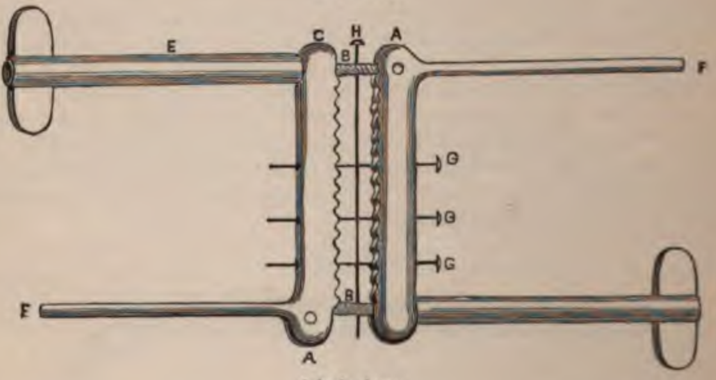
[1] Stimson advises that the cyst should be fixed in the abdominal wound, and opened, the operator's hand being then passed into the interior to explore and search for adhesions from within.

[2] Miner's method of enucleation has also been applied to uterine tumors by Spiegelberg, and by Moore, of Rochester; the former surgeon, after enucleation, closes the peritoneum over the uterus by the introduction of sutures, while the latter brings the pedicle out and fixes it in the abdominal wound in the ordinary way.

FIG. 464.



Atlee's clamp.

The pedicle being secured, and the tumor removed, the surgeon examines the other ovary (excising it also, if it be diseased), and then, having cleansed the peritoneum by careful sponging, closes the wound with large harelip pins, or with deep and superficial sutures, and applies water-dressing or oiled lint, supporting the whole abdomen with a broad flannel bandage. The sutures should be made of silver or flexible iron wire, and the deep set should pass through the whole thickness of the abdominal wall, including the peritoneum. Sims recommends that, unless the antiseptic method be used, a puncture should be made from the vagina, through the recto-uterine fold of the peritoneum (Douglas's *cul-de-sac*), and a drainage tube introduced; or, if enucleation have been practised, two drainage tubes—one into the cavity of the pelvis, and one between the folds of the pedicle;[1] these drainage tubes may, if thought proper, be brought out at the lower part of the abdominal wound, so as to facilitate the use of disinfecting injections, if these should become necessary. Sims's plan has been successfully followed by other surgeons, including Hahn and Spiegelberg, but it is thought unadvisable by Spencer Wells, who reserves puncture and drainage for exceptional cases. Most modern ovariotomists attach great importance to the observance of all the antiseptic precautions insisted upon by Prof. Lister; but others, including such successful operators as Keith and Lawson Tait, prefer to dispense with the spray and other Listerian precautions, and rely exclusively upon care and cleanliness in their cases.

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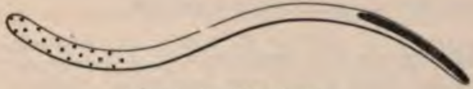
[1] Dr. A. Dunlap, of Ohio, recommends that the pedicle itself should be inverted through the vagina.

The *after-treatment* consists in adopting means to prevent the occurrence of peritonitis, which is the cause of death in about one-fourth of the fatal cases. The patient should be kept perfectly quiet and tranquil, and fed upon liquid diet for ten days or a fortnight after the operation. A Sims's catheter should be retained in the bladder during the first four or five days, and the bowels locked up by the moderate use of opium for about two weeks. If there be much tympanitic distension, a simple enema may be given on the eighth or ninth day. The chief sources of danger, beside shock and nervous prostration, are secondary hemorrhage, peritonitis, and septic poisoning; the latter is, indeed, according to Sims, the principal cause of death after the operation. Hemorrhage must be arrested by exposing or opening the wound, and securing the bleeding vessel in the pedicle, and peritonitis is to be treated in the way described in previous chapters. Koeberle applies an ice-bag on either side of the incision, as a prophylactic against both of these complications. Wells and Thornton apply cold to the head by Petigand's coil, as a means of reducing the temperature of the body. Bozeman lays great stress upon the administration of quinia and opium, in large doses, by the rectum. Should symptoms of septic poisoning supervene, the lower part of the incision should be opened sufficiently to allow the introduction of an elastic catheter, through which disinfectant solutions may be injected and the peritoneal cavity washed out, as recommended by Dr. Peaslee. This surgeon reports several successful cases, in one of which no less than 135 injections were made in the course of 78 days. The best disinfectants for the purpose are probably the Liq. sodæ chlorinatis and carbolic acid, either being, of course, very much diluted. Quinia should, at the same time, be freely given internally. The sutures may be removed, a few at a time, from the fifth to the tenth day.

FIG. 465.



Sims's sigmoid catheter.

Vaginal Ovariotomy, or the removal of an ovarian tumor through the posterior wall of the vagina, an operation which has been practised by Thomas, Wing, Davis, Gilmore, and Goodell, may occasionally be preferred to the ordinary operation, but is manifestly suited only to cases in which the tumor is small, and free from adhesions.

Rectal Ovariotomy.—Mr. A. W. Stocks, an English surgeon, has recorded a remarkable case, in which an ovarian cyst protruded through the rectum, and was successfully removed through an incision in the anterior wall of that organ.

Normal Ovariotomy; Oophorotomy; Oophorectomy; Battey's Operation.—These names have been applied to an operation introduced by Hegar, of Freiburg, and Battey, of Georgia, and since repeated by numerous surgeons, both at home and abroad; it consists in the removal of one or both ovaries, even when not obviously diseased, as a means of hastening the menopause, when that may seem desirable. The glands are removed either by abdominal section or through the posterior wall of the vagina, as in Thomas's operation of vaginal ovariotomy. Engelmann has analyzed 36 terminated cases, and finds that 8 patients were cured, 8 improved, 9 not benefited, or made worse, while 11 died. Battey has collected 54 cases, with 15 deaths; and 121 cases, collected by Dr. Munde, furnished 28 deaths; but there is reason to believe that even these figures do not represent the full mortality. Altogether, the record seems to me not to justify a resort to the operation, unless under exceptional circumstances. It is, however, right to add that some writers, such as Lawson Tait, who reports 31 cases with only 4 deaths, consider the operation almost free from danger.

Double Ovariotomy was first performed by Dr. J. L. Atlee, of Lancaster, Pa., in 1843, and has been since very frequently repeated. The operation is attended with but little greater difficulty and risk than that of removing a single ovary, but has the necessary disadvantage of rendering the patient sterile.

Extirpation of both Ovaries and of the Uterus has been not unfrequently performed, but usually with a fatal result (see Chapter XLVII.). In the light of past experience, the repetition of the operation cannot be recommended, though it is, of course, possible that wider observation may, at some future time, compel the rendition of a more favorable verdict with regard to this operation, as it has already done with regard to the simpler procedure of ovariotomy.

CÆSAREAN SECTION, ETC.

The Cæsarean section may be performed with the hope of saving the child alone (in case of sudden death occurring to a woman far advanced in pregnancy), or with the hope of saving both mother and child, in cases of extreme deformity of the pelvis, etc. The operation consists in opening the abdominal cavity in the median line (as in ovariotomy), incising the womb, rupturing the membranes, and extracting with the least possible delay both child and placenta. Bleeding is then to be arrested, the peritoneal cavity cleansed by sponging, and the uterine wound and that of the abdominal parietes separately closed with sutures. Some difference of opinion prevails as to whether sutures should or should not be applied to the uterus; if it be determined to use them (as seems to me judicious), the material should be silver or iron wire, or strong silk or thread; if, on the other hand, uterine sutures are to be dispensed with, a drainage-tube may be properly introduced (as advised by Depaul), one end coming out by the abdominal wound, and the other by the vagina. The after-treatment is directed to the prevention of peritonitis. When performed during the first 24 hours of labor, the statistics of the operation are more satisfactory than might be anticipated, 28 American cases, collected by Harris, of this city, having resulted in the preservation of 21 mothers and 19 children. The same writer has collected, in all, 132 cases from American sources, giving a total mortality of 62 mothers. Porro, Spaeth, Muller, E. Richardson, and others, have reported successful cases of Cæsarean section supplemented by extirpation of the uterus: 91 such cases, tabulated by Harris, have given 38 recoveries with 66 children saved, and 53 maternal deaths. The Cæsarean section has been occasionally repeated on the same patient, in successive pregnancies, from two to seven times.

Laparotomy for rupture of the pregnant uterus is often spoken of as a variety of Cæsarean section, but is, according to Harris, a much less serious operation. The steps of the procedure are the same as in the former case, except that the incision of the womb is not required.

Laparotomy may be called for in cases of *extra-uterine pregnancy.* The abdominal cavity having been opened, the sac containing the fœtus is carefully incised, and the fœtus removed. Koeberle, Lawson Tait, and Harris, advise that the placenta should be left *in situ*, the peritoneal cavity being carefully closed, while the abdominal sac is left open. The placenta is ultimately discharged piece-meal, when the sac, which must be frequently washed out by syringing, gradually becomes obliterated.

Laparo-elytrotomy, or opening the vagina through the abdominal wall, above Poupart's ligament (an operation devised by Ritgen, Physick, and Baudelocque), is recommended by Thomas and Skene, as a substitute for Cæsarean section. Eleven cases, collected by Kinkead, of Galway, resulted in four recoveries and seven deaths. Another successful case has since been reported by Dr. W. R. Gillette.

NEPHROTOMY FOR RENAL CALCULUS (NEPHRO-LITHOTOMY).

Calculous concretions have been not unfrequently extracted from the kidney or ureter, in cases in which the existence of an abscess[1] or urinary fistula has served as an indication for the proceeding, but the first formal nephrotomy for the removal of renal calculus appears to have been performed by an Italian surgeon, named Marchetti, in the latter part of the seventeenth century. Several concretions were extracted, and the patient recovered with a renal fistula. The revival of this operation has been recently advocated by T. Smith (in a paper in the *Medico-Chirurgical Transactions,* vol. lii.), who recommends a longitudinal incision along the outer border of the erector spinæ muscle, extending downwards four inches from the lower margin of the last rib. The incision is cautiously deepened until the finger can be placed upon the hilus of the kidney, when, if thought proper, this organ can be laid open. This operation does not involve the peritoneal cavity, so that there is little risk of peritonitis, while urinary infiltration is prevented by the depending position of the wound. The great objection to the procedure is the difficulty of deciding (1) whether renal calculus exists at all, (2) which kidney is affected, and (3) whether the calculus be not so adherent as to render its extraction impossible. Since the publication of Mr. Smith's paper, the operation has been tried in at least 28 cases, 10 times without finding any stone, and 12 times with a fatal result. Nephrotomy for hydro-nephrosis and pyo-nephrosis will be referred to in another place.

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[1] As in the case of the late Mr. Startin, a well-known English surgeon, and in a case recently recorded by Petersen.

Cases of Nephro-lithotomy.

No.	Operator.	Result.	No.	Operator.	Result.
1	Annandale,	No calculus found.	16	Durham,	No calculus found.
2	Id.	"	17	Golding-Bird,	"
3	Baker,	Died.	18	Gunn,	"
4	Barbour,	No calculus found.	19	Haward,	Recovered.
5	Bardenheuer,	?	20	Id.	Died.[1]
6	Barker,	Died.	21	Lente,	No calculus found.
7	Beck,	Recovered.	22	Lucas,	"
8	Butlin,	"	23	Marchetti,	Recovered.
9	Callender,	Died.	24	May,	Died.
10	Clark,	Recovered.	25	Morris,	Recovered.
11	Couper,	Died.	26	Mynter,	Died.
12	Cullingworth,	"	27	Richet,	"
13	Dawson,	"	28	Thornton,	No calculus found.
14	Duncan,	"	29	———	Died.
15	Id.	No calculus found.			

Extirpation of the Kidney (Nephrectomy).

First practised by Wolcott, in 1861, this operation was formally undertaken for the first time by Simon, of Heidelberg, eight years afterwards, in a case of urinary fistula following a wound of the ureter, inflicted in removing the uterus and ovary. The kidney may be reached either by lumbar incision or by abdominal section, the former being probably the preferable method, except in cases of floating kidney, when the anterior operation should be chosen. Nephrectomy by one or other plan has been performed in at least 103 cases, 47 of which are known to have proved fatal.

These results, while not very encouraging, are sufficiently favorable to justify a resort to the operation in cases of incurable disease of the kidney, in which there is reasonable ground for believing that the other kidney is capable of discharging its function in a normal or almost normal manner. In order to ascertain this point, Gluck suggests that the ureter of the kidney known to be diseased should be first exposed, and temporarily ligated or compressed, while the eliminating power of the opposite organ is tested by the hypodermic injection of some substance which, like the ferrocyanide of potassium or iodide of sodium, passes rapidly into the urine. The suggestion is certainly ingenious, but the proposed test seems to me hardly certain enough to be implicitly relied upon in practice. Hahn recommends, in cases of floating kidney, that, instead of extirpating the organ, the surgeon should cut down in the lumbar region, and fix the wandering viscus in the wound with catgut sutures. The operation, which he has practised in two cases, he declares to be quite "devoid of danger."

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[1] Calculus found in other kidney.

Cases of Nephrectomy.[1]

No.	Operator.	Result.	No.	Operator.	Result.
1	Adams,	?	53	Kehrer,	Recovered.
2	Archer,	Recovered.	54	Kocher,	Died.
3	Baker,	"	55	Id.	"
4	Bardenheuer,	Died.	56	Lange,	"
5	Id.	Recovered.	57	Id.	"
6	Id.	Died.	58	Langenbuch,	Recovered.
7	Id.	Recovered.	59	Id.	"
8	Id.	?	60	Id.	"
9	Id.	?	61	Le Dentu,	"
10	Id.	?	62	Le Fort,	Died.
11	Barker,	Died.	63	Leopold,	Recovered.
12	Id.	"	64	Lossen,	"
13	Id.	"	65	Lucas,	"
14	Barwell,	"	66	Lücke,	Died.
15	Id.	Recovered.	67	McClelland,	Recovered.
16	Baum,	Died.	68	Marsh,	Died.
17	Billroth,	"	69	Martin,	Recovered.
18	Id.	"	70	Id.	"
19	Brandt,	Recovered.	71	Id.	"
20	Bruns,	Died.	72	Id.	"
21	Burgess,	"	73	Id.	Died.
22	Byford,	Recovered.	74	Id.	"
23	Campbell,	"	75	Id.	Recovered.
24	Clementi,	"	76	Id.	Died.
25	Couper,	"	77	Martini,	Recovered.
26	Crédé,	"	78	Marvaud,	"
27	Czerny,	Died.	79	Meadows,	Died.
28	Id.	Recovered.	80	Merkel,	"
29	Id.	Died.	81	Müller,	Recovered.
30	Id.	Recovered.	82	Peaslee,	Died.
31	Id.	"	83	Peters,	"
32	Id.	"	84	Raffa,	Recovered.
33	Id.	Died.	85	Rosenbach,	"
34	Id.	"	86	Savage,	"
35	Id.	"	87	Simon,	"
36	Id.	Recovered.	88	Id.	Died.
37	Id.	"	89	Smith,	?
38	Id.	Died.	90	Smyth,	Recovered.
39	Id.	?	91	Spiegelberg,	Died.
40	Dumreicher,	Died.	92	Id.	Recovered.
41	Durham,	"	93	Starck,	"
42	Esmarch,	"	94	Stockwell,	Died.
43	Frattina,	"	95	Thomas,	Recovered.
44	Gilmore,	Recovered.	96	Thornton,	"
45	Godlee,	Died.	97	Id.	"
46	Golding-Bird,	"	98	Id.	"
47	Hamilton,	Recovered.	99	Urbinati,	Died.
48	Heath,	Died.	100	Whitehead,	"
49	Id.	"	101	Wolcott,	"
50	Hicguet,	Recovered.	102	Zweifel,	Recovered.
51	Hüter,	Died.	103	———	Died.
52	Jessop,	Recovered.			

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[1] For several of these cases I am indebted to Dr. Harris's excellent paper in the *American Journal of the Medical Sciences*, for July, 1882.

Extirpation of the Spleen (Splenectomy).

The spleen has been partially or wholly excised for traumatic causes, and in cases of cystic disease, of "floating spleen," and of chronic enlargement connected with leucocythæmia. Dr. Otis tabulated 26 cases of splenectomy for all causes; but from these should be deducted one (Dorsey's), in which the organ was replaced in the abdominal cavity and not removed. To the remaining 25 cases may be added 35 others, giving a total of 60 operations, 21 having been for traumatic causes, and all having terminated successfully, while of the 39 operations for disease all but 9 ended in death. While, therefore, excision would appear to be justifiable in cases of wound attended by protrusion of the organ, splenectomy for diseased conditions of the viscus has not been sufficiently successful to afford much encouragement for a repetition of the procedure. Hemorrhage, during or subsequent to the operation, appears to have been the cause of death in most of the fatal cases.

Cases of Splenectomy for Injury.

No.	Operator.	Result.	No.	Operator.	Result.
1	Alston,	Recovered.	12	Matthias,	Recovered.
2	Bazille,	"	13	O'Brien,	"
3	Berthet,	"	14	Pietrzycki,	"
4	Dorsch,	"	15	Powell,	"
5	Elias,	"	16	Schultz,	"
6	Fantoni,	"	17	Wilson,	"
7	Faris,	"	18	———	"
8	Ferguson,	"	19	———	"
9	Hunter,	"	20	———	"
10	MacDonnell,	"	21	———	"
11	Markham,	"			

Cases of Splenectomy for Disease.[1]

No.	Operator.	Result.	No.	Operator.	Result.
1	Aonzo,	Died.	21	Koeberle,	Died.
2	Arnison,	"	22	Id.	"
3	Billroth,	"	23	Küchler,	"
4	Id.	"	24	Lane,	"
5	Bonora,	"	25	Martin,	ecovered.
6	Brown,	"	26	Miner,	Died.
7	Browne,	"	27	Péan,	Recovered.
8	Bryant,	"	28	Id.	"
9	Id.	"	29	Quittenbaum,	Died.
10	Chiarleoni,	"	30	Simmons,	"
11	Crédé,	Recovered.	31	Urbinati,	"
12	Czerny,	"	32	Id.	"
13	Id.	Died.	33	Watson,	"
14	Id.	Recovered.	34	Wells,	"
15	Dewolf,	Died.	35	Id.	"
16	Ferrerius,	Recovered.	36	Id.	"
17	Franzolini,	"	37	Zaccarello,	Recovered.
18	Fuchs,	Died.	38	———	Died.
19	Geissel,	"	39	———	"
20	Haward,	"			

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[1] For six of these cases I am indebted to Dr. Harris.

RESECTION OF THE STOMACH (GASTRECTOMY).

Resection of the Pyloric Extremity of the Stomach was originally suggested by a young German physician named Merrem, and afterwards by Gussenbauer and Winiwater, as a remedy for cancer of that organ. First put in practice by Péan, the operation appears to have been now performed in 19 cases, 6 of which are said to have terminated successfully.

Cases of Pyloric Gastrectomy.

No.	Operator.	Result.	No.	Operator.	Result.
1	Bardenheuer,	Died.	11	Kitajewski,	Died.
2	Berns,	"	12	Lauenstein,	"
3	Billroth,	"	13	Ledderhose,	"
4	Id.	"	14	Nebinger,	?
5	Id.	"	15	Nycolaisen,	Died.
6	Id.	Recovered.	16	Péan,	"
7	Id.	"	17	Rydygier,	Recovered.
8	Caselli,	Died.	18	Southam,	Died.
9	Cavazzini,	Recovered.	19	Wölfler,	Recovered.
10	Czerny,	"			

Resection of the Cardiac Extremity of the Stomach appears to have been performed only once, by Dr. L. C. Lane, of California, and that case terminated fatally on the second day.

In spite of the measure of success which is alleged to have attended these operations, I confess that they seem to me hardly within the pale of legitimate surgery.

PANCREATECTOMY AND PANCREATOTOMY.

Pancreatectomy, or excision of a portion of the pancreas, in cases of abdominal wound with protrusion of that organ, appears to have been successfully performed in six cases by Caldwell, Laborderie, Kleberg, Thompson, Justin, and B. Allen.

Pancreatotomy, with excision of a cyst of the pancreas, has been resorted to in four cases, by Bozeman, the younger Rokitansky, Kulenhampff, and Thiersch. Rokitansky's patient died on the tenth day, but the others all appear to have recovered.

HEPATECTOMY AND HEPATOTOMY.

Excision of a protruding portion of the liver (*partial hepatectomy*) has occasionally been resorted to in cases of penetrating wound of the abdomen, but does not appear to have been practised, as yet, for disease of that organ. Lawson Tait and Ransohoff have successfully employed simple *hepatotomy* in cases of hepatic abscess, hydatid cyst, etc.

Gastrostomy, Enterostomy, and **Gastro-enterostomy** have already been referred to on pages 770, 772.

TREATMENT OF ABDOMINAL ABSCESSES.

The surgeon is occasionally called upon to evacuate collections of pus which have been formed in connection with the liver, gall-bladder, spleen, kidney, intestinal canal, or ovary, or in the deep layers of areolar tissue found in the neighborhood of the broad ligament.

Hepatic Abscess is not unfrequently met with in tropical regions. The pus may occasionally find a vent into a neighboring portion of intestine, or may perforate the diaphragm and enter the lung, or finally may point externally. In the latter case, surgical interference may be required, the *treatment* consisting in puncturing the abscess with an aspirator or a small trocar and canula, the latter being provided with a stopcock, as in the operation for paracentesis thoracis. Sistach, however, employs a large trocar, and washes out the cavity of the abscess with injections of dilute tincture of iodine. The puncture should not be made until the signs of external pointing show that adhesions have been formed between the visceral and parietal layers of peritoneum, but, if the other symptoms be urgent, an attempt may be made to hasten this occurrence, by the use of blisters or caustics, by making a superficial incision over the part, or by the introduction of acupuncture needles. The same means may be resorted to in dealing with other abdominal abscesses. Dr. Isham, of Ohio, has reported a remarkable case in which an hepatic abscess, bursting through the diaphragm, was successfully evacuated by an incision through the walls of the chest. Lawson Tait has successfully evacuated an hepatic abscess by abdominal section, and Ransohoff has been equally fortunate by employing the thermo-cautery.

Biliary Abscess.—The surgical *treatment* of abscess originating in the gall-bladder, is to be conducted on the same principles as that of hepatic abscess.

Splenic Abscess is of rare occurrence. The *treatment* consists in evacuating the pus by means of a trocar and canula, as soon as adhesion has occurred between the adjacent layers of peritoneum.

Perinephritic Abscess, Pyonephrosis, and Hydronephrosis.—Collections of pus, originating in the areolar and adipose tissue around the kidney, may find a vent by bursting into the kidney itself, or into the bladder (the pus then escaping in the urine), by perforating the diaphragm and entering the thoracic cavity, or by opening into the vagina or bowel, or on the external surface, usually in the hypochondriac or lumbar region. This affection has been particularly studied by Trousseau, and more recently by Gibney, of New York, and Bowditch, of Boston, the last-named author having particularly insisted upon the importance of early surgical interference. The *treatment* consists in making a puncture or incision to evacuate the contents of the abscess, as soon as the existence of pus has been ascertained with reasonable certainty: the opening should as a rule be made in the *lumbar* region, because the kidney can be reached from behind without wounding the peritoneum; if, however, absolute pointing of the abscess should have occurred anteriorly, indicating the formation of adhesions between the adjacent layers of peritoneum, the opening should rather be made at the point at which fluctuation is most distinct. With regard to the comparative advantages of *incision*, and of *puncture* with a trocar and canula, I should prefer the former; the objection usually urged is that the use of the bistoury is more apt to be followed by hemorrhage, but then, if hemorrhage should occur, a free opening would afford greater facility for its control. Perhaps the best plan would be to make a superficial incision, and then thrust in a grooved director in the way recommended by Hilton for the opening of deep-seated abscesses in other situations (see page 392). Even if the flow of pus do not immediately follow the operation, Dr. Bowditch's experience has shown that the symptoms are quickly relieved, the swelling gradually melting away, as it were, under the influence of the suppuration which subsequently occurs. *Pyonephrosis*, or suppuration within the kidney, has been successfully treated by cutting into the organ (*nephrotomy*) in 17 cases, only 4 of which appear to have terminated fatally.

Cases of Nephrotomy for Pyonephrosis.

No.	Operator.	Result.	No.	Operator.	Result.
1	Ancrum,	Recovered.	10	Lange,	Recovered.
2	Baker,	"	11	Lellman,	Relieved.[1]
3	Callender,	"	12	Lente,	Recovered.
4	Crane,	Died.	13	Puzey,	"
5	Davies-Colley,	Recovered.	14	Roddick,	"
6	Id.	Died.	15	Svenson,	"
7	Gaston,	"	16	Weir,	Died.
8	Heath,	Recovered.	17	Williams,	Recovered.
9	Heustis,	"			

Nephrotomy for *hydronephrosis*, or accumulation of urine in the kidney, has been unsuccessfully employed by Nicaise, as has tapping and an attempt to secure adhesion between the orifice and the abdominal wound, by Spencer Wells. Successful nephrotomies for hydronephrosis have, however, been recorded by Weir, Peters, Waille, and Ahlfeld. In a second case in which Peters attempted the operation, the patient died, and an autopsy showed that the liver had been cut into instead of the kidney, which was healthy. Savage's and Thornton's successful nephrectomies for hydronephrosis have already been referred to (page 875). The injection of iodine has been successful in the hands of Schrötter and Billroth, as has double puncture, followed by incision and daily washing out the cavity, in those of Simon.

Fecal or Stercoraceous Abscess may originate in connection with any part of the intestinal canal, but its most common seat is the neighborhood of the cæcum or appendix vermiformis, where it constitutes *Perityphlitic Abscess.* Fecal abscess may result from injury, or from perforation of the bowel occurring in the course of typhoid fever, but its most common cause is the irritation produced by a foreign body. The *treatment* consists in making a free incision as soon as the occurrence of pointing renders it probable that adhesions have been formed between the parietal peritoneum and that covering the wall of the abscess. If the patient recover, it will probably be with a fecal fistula, which must be treated as directed at page 382. Hancock, W. Parker, Buck, Sands, and others, recommend that the abscess should be opened by an early incision, which may be made behind the peritoneum as in the operation for tying the external iliac artery. Dr. Gouley, of New York, has collected 25 cases operated on in this manner, 23 having terminated in recovery, and only 2 in death. Burchard advises that, in case of perforation, the peritoneal cavity should be opened (with antiseptic precautions) and thoroughly cleansed, and the ulcerated appendix secured by stitches to the external wound.

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[1] Nephrectomy (fatal) afterwards performed by Lange.

Ilio-Pelvic Abscess originates usually in connection with the ovary, broad ligament, or retro-peritoneal areolar tissue, the affection being, in most instances, met with as a complication of the puerperal state. The pus may find its way into the rectum, uterus or vagina, bladder, or peritoneal cavity, or, if peritoneal adhesions have been formed, may point externally. When it is thought proper to open the abscess, this may be done by cautious incision, or by puncture with a trocar and canula, through the posterior wall of the vagina, the rectum, or the abdominal wall. If the latter situation be chosen, the operation should be delayed until after the establishment of adhesions between the adjacent layers of peritoneum. Lawson Tait, however, prefers abdominal section, with the subsequent use of a drainage tube.

Suppuration occurring in an Ovarian Cyst (often though incorrectly called *Chronic Ovarian Abscess*) has been successfully treated by Bryant, by making an incision in the median line of the abdomen, laying open the cyst, stitching its walls to the edges of the external wound, and subsequently washing out the cavity daily by means of a syringe.

HYDATIDS, SEROUS CYSTS, ETC.

The surgeon is occasionally called upon to open *hydatids*, which occur in the liver, and more rarely in other organs. The opening may be made either with caustic or with the trocar and canula, with the same precautions against the escape of fluid into the peritoneal cavity as in the case of hepatic abscess. Dr. Southey, of St. Bartholomew's Hospital, London, has recorded a case of *intra-thoracic* hydatid, in which the cyst, after being tapped, was extracted through a free incision between the ribs; the patient recovered. Israel and Genzmer have successfully removed hydatids of the liver by excising a portion of rib, and then cutting through the diaphragm. Fitzgerald, of Melbourne, and Lawson Tait have, in similar cases, operated successfully by abdominal section.

The use of the trocar is also sometimes resorted to in cases of *serous cyst of the liver, kidney, spleen* or *urachus*, or in those of *distension of the gall-bladder* from accumulation of the biliary secretion.

The same precautions should be adopted here as in the case of hydatids.

Cholecystotomy, or opening the gall bladder for the removal of biliary calculi, an old operation which was described by Sharp in the early part of the last century, and has since been occasionally practised, by Bobbs and others, has been recently revived by Marion Sims, in the case of a lady who died on the ninth day, and by W. W. Keen, in that of an old woman who died in thirty-six hours. Recoveries after this operation have, however, been recorded by Lawson Tait and Ransohoff, and Bryant has successfully removed a gall-stone by enlarging a biliary fistula which communicated with the offending substance. The case recorded by Mr. G. Brown does not seem to me to have been a true "cholecystotomy."

CHAPTER XLIV.

URINARY CALCULUS.

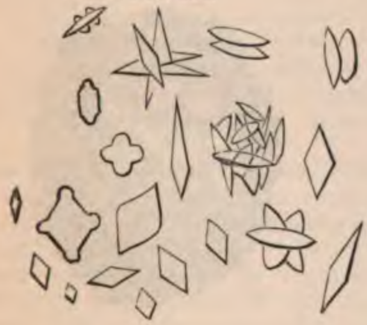
In the urine are found deposits of various solid substances, which when in the form of an impalpable powder are called *sediments*, when granular or crystalline are spoken of as *gravel*, and when concreted into masses constitute *calculi* or *stones*. The constitutional conditions which precede or accompany the formation of these deposits are often called *diatheses*, and surgeons thus speak of the *uric acid*, the *oxalic*, and the *phosphatic*, *diathesis*.

VARIETIES OF CALCULUS.

The most common and therefore the most important varieties of calculus are those composed respectively of uric acid, oxalate of lime, and phosphatic salts. Beside these, other varieties are occasionally met with, in which the concretion is composed of urates, cystine, xanthine, fatty matter, carbonate of lime, etc.

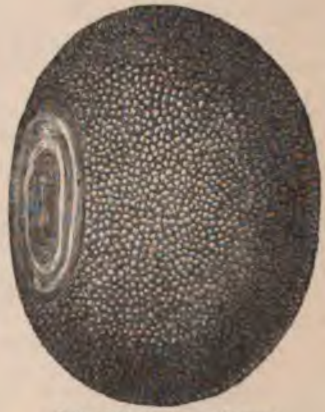
Uric Acid Calculus.—This is very common, constituting, according to Roberts, five-sixths of all renal calculi, and of vesical calculi which have recently descended from the kidney. When uric (or lithic) acid is deposited as *gravel*, it occurs in the form of little crystalline masses or flattened concretions of a yellowish or reddish-brown color. The uric acid calculus is ordinarily of moderate size, of a flattened oval form, and of a fawn color; on section, it is often found to be composed of concentric laminæ. Its weight rarely exceeds an ounce. The surface of the stone is usually smooth and somewhat mammillated, but occasionally rough and manifestly crystalline. The best test for uric acid is the development of a bright violet or purple hue (*murexid*), on applying the vapor of ammonia to the residue left

Fig. 466.



Uric acid deposits. (Holmes.)

Fig. 467.



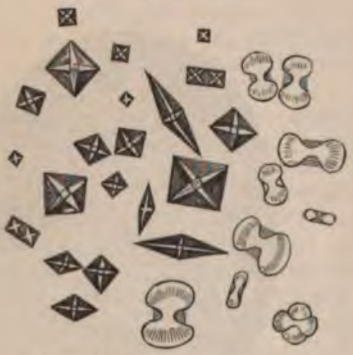
Uric acid calculus. (Gross.)

by treating the suspected substance with nitric acid and heat. The urine of patients with uric acid calculus is acid, and frequently high-colored; it often deposits uric acid crystals and amorphous urates. This form of stone is met with among free livers, especially those of a gouty habit, and among strumous, over-fed children.

Urates.—The urates of potassium, sodium, and ammonium are not unfrequently deposited in the form of an amorphous sediment in urine *after it has been voided*, constituting the common *lateritious deposit* which is met with in febrile affections, or which may occur from mere concentration of the urinary secretion; but *calculi* composed of urates are very rare. They are almost exclusively observed in young children, and as *renal* concretions; though it is probable that urates occasionally form the *nucleus* of a *vesical* stone. The exact chemical composition of these calculi is a matter of some doubt, most authorities regarding them as concretions of *urate of ammonium*, though one of the latest writers, Roberts, of Manchester, appears to regard them as consisting of *urate of sodium*. Urate calculi are soft, and never large; they may be recognized by their solubility in hot water. *Urate of ammonium* is often deposited in connection with *phosphates* from ammoniacal urine, and is thus met with in the outer layers of vesical calculi.

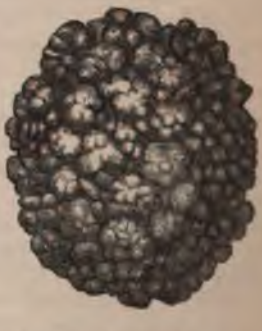
Oxalate of Lime Calculus (*Mulberry Calculus*).—When evacuated in the form of gravel, oxalate of lime occurs as minute seed-like concretions, of a smooth and rounded form, and of a grayish-brown color. The oxalate of lime calculus is hard, of a somewhat spherical shape, dark-brown or black (more rarely bluish-gray) in color, and tuberculated on the surface, somewhat resembling a mulberry. It rarely attains a large size. Oxalate of lime and uric acid are often deposited in alternate layers, the calculus consisting of more or less perfect concentric laminæ; the nucleus of such a calculus is usually composed of uric acid. Oxalate of lime is soluble in nitric and hydrochloric acids, and when treated with the blowpipe leaves a residue of lime, which blues reddened litmus, and browns turmeric. The deposit of oxalate of lime appears to be due to an imperfect metamorphosis of the azotized constituents of the blood, originating sometimes in errors of diet, or in exposure to bad hygienic conditions of various kinds. The oxalate of lime calculus is, as shown by Carter, much commoner in India than in cooler countries.

Fig. 468.



Oxalate of lime deposits. (Holmes.)

Fig. 469.

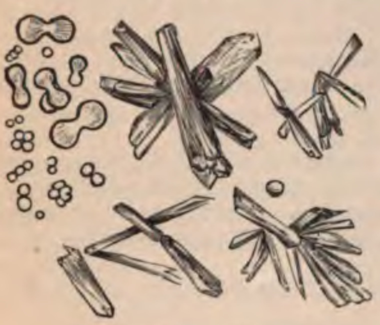


Mulberry calculus. (Miller.)

Phosphatic Calculus.—Of this there are three varieties:—

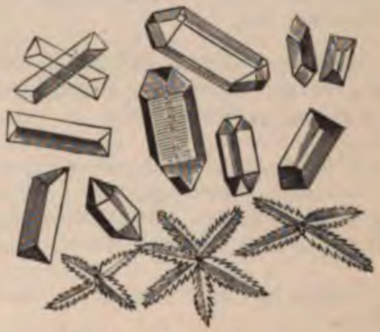
1. *Amorphous Phosphate of Lime* (*Bone Earth*) is rarely met with as the sole constituent of a calculus. Stones of this variety are of a whitish, chalky, or pale-brown color, are smooth and friable, and sometimes attain a considerable size. The phosphate of lime calculus may be recognized by its solubility in nitric and hydrochloric acids, and by its being totally infusible before the blowpipe. Phosphate of lime is also met with in the urine in a *crystalline* form (*stellar phosphate*), but does not under these circumstances occur as a calculus. The presence of amorphous phosphate of lime in the urine depends solely on the alkaline condition of that secretion.

FIG. 470.



Phosphate of lime. (HOLMES.)

FIG. 471.



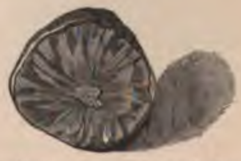
Triple phosphate. (HOLMES.)

2. *Phosphate of Ammonium and Magnesium* (*Triple Phosphate*).—This is more common than the phosphate of lime; the stones are of a whitish-gray color, and evidently composed of crystals. The triple phosphate is soluble in acetic or in hydrochloric acid, and is precipitated by an excess of ammonia, in a crystalline form. It is with difficulty fusible before the blowpipe.

3. *Mixed or Fusible Calculus.*—This variety is formed of a mixture of the phosphate of lime and triple phosphate; it often occurs as a white mass, easily broken up, and resembling mortar; it is characterized by the great facility with which it may be fused before the blowpipe. The mixed phosphates rarely constitute the whole of a calculus, but, on the other hand, very frequently form some of the outer layers, deposited upon uric acid or other nuclei, or upon foreign bodies. The triple phosphate and mixed phosphates are met with in alkaline and especially in ammoniacal urine.

Cystine Calculus.—This is a rare form of calculus. It is of a yellow color and has usually an oval shape, and a mammillated and slightly lustrous surface. On section, it presents a radiated appearance, and is at first of a yellow-wax-like color, turning to a pale green by long exposure to the light. Cystine is soluble in the mineral acids, and in ammonia; when precipitated from a solution in the latter (by evaporation of the solvent), it appears in the form of characteristic six-sided crystals.

FIG. 472.



Section of a cystine calculus, with a nucleus of uric acid, and an external coat of phosphates. (ROBERTS.)

Xanthine or Xanthic Oxide is a very unusual constituent of calculous concretions; it is soluble in ammonia, but does not crystallize when precipitated.

Fatty or Saponaceous Matters (*Urostealith*) have been occasionally found in calculi; the origin and precise nature of the substances in question are not positively known.

Carbonate of Lime Calculi are very rarely met with. They are always small; are white, yellow, or ash-colored; and are smooth, hard, and sometimes lustrous.

Fibrinous Calculi and Blood Calculi have been described by various writers, but can scarcely be considered as urinary deposits. They are called by Poland *pseudo-calculi.*

Silica is occasionally met with as a constituent of calculi, but the masses which have been supposed to be entirely formed of this substance, have been, according to Poland, pebbles or small stones introduced from without. The same may probably be said of calculi reported to be composed of *iron.*

Indigo has been found as a constituent of renal calculus by Dr. W. M. Ord.

For further information with regard to the various forms of urinary deposit and urinary calculus (of which the foregoing very brief sketch is all that the limits of this volume will allow), I would refer the student to special works on the diseases of the urinary organs, and particularly to the writings of Bird, Jones, Beale, and Roberts.

Renal Calculus.

Renal calculi are, in the large majority of instances, composed of uric acid. The symptoms produced by a renal calculus consist of pain of an aching character in the lumbar region, with occasional aggravations (*nephritic colic*) in which the pain shoots downwards towards the scrotum and inner part of the thigh, and is attended by nausea or vomiting, and by dysuria and increased frequency of micturition. The urine at such times may contain blood, pus, or epithelial scales. When a calculus escapes from the kidney into the ureter, giving rise to a *fit of the stone*, the symptoms are greatly aggravated. The patient is suddenly seized with intense pain, radiating down the inside of the thigh and into the spermatic cord and testicle, the latter organ being retracted. There is constant vomiting, with a feeling of great prostration, constipation, partial suppression of urine, and, if the attack continue, decided febrile disturbance. The symptoms quickly subside when the calculus reaches the bladder, but if, as sometimes happens, the concretion become impacted in the ureter, dilatation of that tube will ensue, with consequent disease of the corresponding kidney. Should impaction occur on both sides, a fatal result will be inevitable. In order to facilitate the diagnosis of renal calculus, *catheterization of the ureters* has been practised, in the male by Tuchman and Grünfeld (the latter by the aid of the endoscope), and in the female, after a preliminary vaginal cystotomy, by Simon.

Treatment of Renal Calculus.—During the descent of a calculus, which may occupy several days, the patient should be kept fully under the influence of opium—warm baths, with hot fomentations or poultices to the loins and abdomen, being also of service. In some cases, cupping over the region of the kidney may be required. The bowels should be acted on by means of enemata, and diluents may be freely administered (if the stomach do not reject them) to encourage the flow of urine.

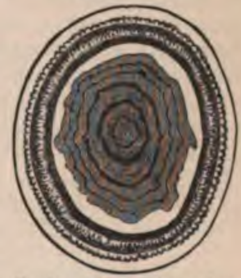
During the intervals between the paroxysms of nephritic colic, an attempt should, in suitable cases, be made to effect the solution of the concretion by the administration of the citrate or acetate of potassium, which are easily taken, and which enter the urine in the form of carbonate. The cases which, according to Roberts, who has specially studied this subject, admit of solvent treatment, are those in which the urine has an acid reaction, and in which the concretion is probably composed of uric acid. In such cases, from two to three scruples of either of the salts named may be given in three or four fluidounces of water, regularly every three hours. The operation of *nephrotomy* for the relief of renal calculus has already been referred to (p. 873). Emmet has successfully removed a calculus from the *ureter*. The *alkaline* or *solvent* treatment is adapted to cases of renal calculus when the stone is already formed. In the *preventive* treatment of calculus, however, more may be accomplished, as pointed out by Sir Henry Thompson, by the use of saline laxatives, and particularly of certain natural mineral waters, such as those of Friedrichshalle and Carlsbad.

VESICAL CALCULUS.

A vesical calculus may, as has been seen, originate from a concretion which has descended from the kidney; but in other cases stone is primarily formed in the bladder, by the aggregation of small granular particles, around which, as a nucleus, fresh deposits subsequently take place, or by the deposit of calculous matter around some extraneous substance, such as a bullet, pin, straw, or broken catheter, which has been introduced from without.

Structure and Physical Characters of Vesical Calculi. *Structure.*—Calculi may be composed throughout of the same substance, but in many instances consist of several layers or laminæ of different chemical characters, deposited around a central portion or *nucleus*. These stones are called *alternating* calculi. The nucleus is usually composed of uric acid, oxalate of lime nuclei coming next in frequency. When the nucleus is phosphatic, the stone is not alternating, the layers subsequently deposited being phosphatic likewise. Whatever be the primary nature of the calculus, it may become encrusted with phosphates in consequence of an ammoniacal state of the urine, due to vesical irritation. Calculous matter may be deposited around a mass composed of several small concretions aggregated together, the stone then appearing on section to contain several nuclei. In addition to the various constituents of vesical calculi which have already been considered, Carter has shown that an *animal basis* is invariably present; this is never found alone, and is probably not always identical in character. It is best developed in the urate calculi, and is found to present a finely granular, striated, or fibrillated appearance.

FIG. 473.



Section of an alternating calculus. (ERICHSEN.)

Number.—In the majority of instances the bladder contains but a single calculus, but occasionally two or more are found in the same case, and in a few instances very large numbers of stones coexist; the most remarkable case on record is, perhaps, that of Chief-Justice Marshall, from whose bladder Dr. Physick is said, on the authority of Dr. Randolph, to have removed by lithotomy more than one thousand calculi. Sometimes several calculi become glued together by sabulous matter and inspissated mucus, forming one large stone somewhat resembling a grape-shot in miniature.

Shape.—The most common shape of a vesical calculus is a flattened ovoid, though mulberry calculi are often somewhat rectangular, or irregularly rounded, while phosphatic stones are occasionally curiously branched or constricted. When several calculi are present, the opposing surfaces become worn by attrition, various facets being thus developed on the sides which are in contact.

Size.—The size of calculi varies from that of a pin's head to that of a mass several inches in diameter. One of the largest stones known was extracted by a Belgian surgeon named Uytterhoeven, by the supra-pubic method, the concretion in this instance being six and a half inches long and four wide, and weighing over two pounds. Such large stones are, however, seldom seen at the present day, and one or two inches may be considered an average length of the calculi ordinarily met with in practice.

Weight.—The weight of vesical calculi varies as much as their size. The lightest stones mentioned in Crosse's tables weighed three and four grains respectively, and the heaviest, seven and eight ounces; but even this weight has been greatly exceeded by that of stones seen by Mayo, Harmer, Cooper, Mott, Cline, Morand, MacGregor, Hodgen,[1] and other surgeons. The average weight is from one or two drachms to an ounce. Of 704 calculi referred to in Crosse's tables, there were 340 in which the weight was under and 364 in which it was over three drachms. I have myself cut patients successfully for stones weighing less than two grains and more than three ounces.

Hardness.—The hardness varies according to the chemical nature of the calculus—stones of the mulberry variety being the least, and those of the phosphatic the most, easily broken. Some of the latter variety are extremely friable, and of a mortar-like consistency.

Situation.—The situation of calculi in the bladder varies with the amount of urine contained in the organ, the size of the stone, and the position of the patient. The locality in which a stone is usually found upon sounding, is, at least in the case of small calculi, at the *bas-fond* of the bladder; but a stone may at other times rest directly upon the neck of the viscus, or may be lodged above the pubis, or behind the prostate—the latter being, indeed, the usual locality in cases of chronic prostatic enlargement. A calculus usually floats loosely in the bladder, but may be fixed in one of the pouches of the organ (if this be sacculated), when the stone is said to be *encysted;* it may also be *adherent* to the side of the bladder, or may be caught in the orifice of a ureter, or may be partially surrounded by a fungous growth. In other cases calculous matter, instead of being concreted into the form of a stone, is deposited in ridges or layers upon the vesical mucous membrane.

Causes of Calculus.—The causes of stone are in most cases very obscure; the formation of calculous concretions is no doubt, as pointed out by Carter and Ord, due to the presence of colloids in the urine, but the circumstances under which these colloids occur have not yet been clearly ascertained. Occasionally, however, the development of calculus is evidently due to the presence of a foreign body, as a broken catheter, slate-pencil, or hair-pin, or, in some rare cases, the presence of hairs, etc., extruded from a dermoid cyst opening into the bladder.

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[1] Morand is said to have seen a calculus weighing six pounds; in MacGregor's case, over 520 small calculi are said to have coexisted with a large one weighing 51 ounces. Dr. Hodgen, of St. Louis, removed by the supra-pubic method a stone weighing one pound and six ounces.

Age.—Age appears to exercise a decided influence upon the occurrence of calculus, the statistics collected by Civiale, Gross, Coulson, and Thompson, showing that, in round numbers, about two-thirds of the whole number of cases are in persons under twenty, and about two-fifths in those under ten years of age. These figures furnish, however, but an approximation to the true statement, for while, on the one hand, a stone may persist for many years before it is detected, the total number of persons between (*e. g.*) the ages of five and ten is, on the other hand, much larger than at any quinquennial period of adult life, so that the relative proportion of patients at any particular age may be very different from that above given.

Sex.—Persons of the male sex are undoubtedly more apt to be afflicted with vesical calculus than women; but the difference is probably not greater than can be accounted for by the respective anatomical peculiarities of the male and of the female urethra, the escape of small calculi through the latter being much easier than through the former.

Residence.—The frequency of calculous disorders varies in different localities; thus in our own country stone is, according to Gross, more common in the States of Kentucky, Virginia, Tennessee, and Ohio, than in any other regions. In the neighborhood of Philadelphia it is certainly very rare, the records of the Pennsylvania Hospital showing that out of about eighty thousand patients treated in its wards, in one hundred and sixteen years, there were but one hundred and twenty-five cases of stone, a proportion of less than one-sixth of one per cent.

Other Causes.—Among other circumstances which have been supposed to influence the frequency of the occurrence of calculus may be mentioned *race, climate, diet, the use of limestone water, social condition, hereditary predisposition*, etc.

Finally, any circumstance which, by interfering with the excretion of urine, leads to vesical irritation, and, in consequence, to an ammoniacal state of the contents of the bladder, may be considered as predisposing to the production of stone; thus *stricture of the urethra, enlargement of the prostate*, and paralysis of the bladder from *injuries of the spine*, may all act as causes of vesical calculus.

Symptoms of Vesical Calculus.—These vary according to the shape and size of the stone, the age and general condition of the patient, etc. A smooth and rounded calculus produces less irritation than one which is sharp and angular, and a small stone usually causes less disturbance than a large one. In children, though there may be a good deal of local distress, there is seldom much constitutional suffering, the patients often appearing particularly rosy and hearty. This is not, however, invariably the case, and children are occasionally seen who are much emaciated and worn down by the constant irritation produced by the stone. In adults, the general health suffers at a comparatively early period, and inflammation of the bladder and kidney are common complications of stone at this period of life. Phosphatic calculi are usually said to produce more irritation than those of other varieties; but this is, I believe, erroneous, the fact being that cystitis (with an ammoniacal condition of the urine) almost invariably precedes and accompanies the deposit of phosphatic matter.

Pain is usually a prominent symptom of stone, and often the first which attracts attention; beside a dull pain and feeling of weight in the region of the bladder and in the perineum, there is a pain referred to the groins, testes, thighs, or even the arms or soles of the feet, with a peculiar, sharp, cutting pain in the glans penis, which is most marked in children—leading to a habit of squeezing and dragging at the part, and giving rise to elongation and hypertrophy of the prepuce. The pain is usually worst immediately after urinating, from the stone then falling forward on the neck of the bladder, which is the most sensitive part of that organ. In order to prevent this, calculous patients get the habit of making water in the recumbent position. The pain is always increased by riding or walking, or by any movement which causes the stone to jolt about in the bladder; these variations in the amount of pain felt are less marked in those cases in which the stone is habitually lodged behind an enlarged prostate, and are almost absent in cases of encysted calculus.

Frequent and Painful Micturition is a very constant symptom of vesical calculus; in some instances there is absolute incontinence of urine, and in others retention; the flow sometimes stops suddenly from the stone falling over the orifice of the urethra, beginning again when the patient changes his position. The urine often contains blood, and, if there be cystitis, may be heavily loaded with mucus or pus; when the kidneys become implicated, the urine is commonly albuminous. The detection of crystals of uric acid or oxalate of lime in the urine, would serve to throw some light upon the nature of the calculus.

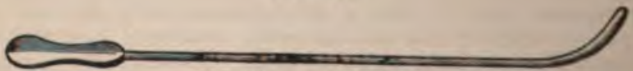
Prolapse of the Rectum is a not unfrequent accompaniment of stone in children, and is occasionally seen in adults; it evidently results from the straining efforts made in the endeavor to empty the bladder.

Priapism and Involuntary Seminal Discharges are among the rarer symptoms of vesical calculus, as is *subconjunctival ecchymosis*, which I have seen in one case from the violent straining efforts in micturition.

Diagnosis.—From observation of some or all of the symptoms mentioned, the surgeon may *suspect* the existence of a calculus in the bladder, but cannot be certain of it until he has elicited physical evidences of the presence of the stone. In children the calculus may sometimes be felt by the finger introduced into the rectum, and in women by a similar exploration, *per vaginam*, but the common means of determining the presence of a stone is by the introduction of a *sound* into the bladder. Very small stones may be detected in this way, and I have thus distinctly recognized, in a child, a calculus, which, when removed by lithotomy, was found to weigh less than two grains.

Sounding for Stone.—A sound is a solid steel instrument of the general shape of a catheter, but with a shorter beak (not much exceeding an inch in length), and more abruptly curved; the handle is made broad and smooth, and the shaft narrower than the beak, which is of a somewhat bulbous shape. The sound may be plated with nickel, which renders it less liable to rust. Sir H. Thompson recommends, as preferable to the ordinary sound, one which is hollow, so as to allow, if necessary, the gradual escape of urine, and

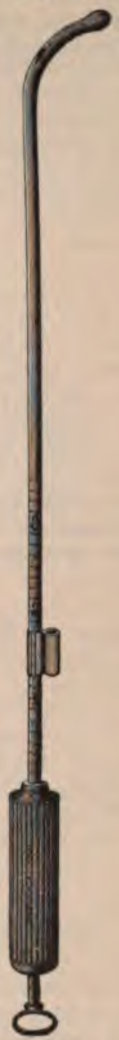
FIG. 474.



Sound for examining bladder.

with a grooved cylindrical handle, which permits more delicacy of manipulation than the broad and flat handle of the instrument commonly employed; the shaft is graduated and provided with a slide, so as to measure the size of the stone. The operation of sounding is occasionally followed by some pain and constitutional disturbance, and should therefore not be performed during the existence of great vesical irritation, but should, under such circumstances, be postponed for a few days, until the irritation has been allayed by the administration of demulcents and other suitable remedies. The operation is thus performed: The patient is laid on his back on a hard mattress, with the hips slightly elevated, and may be etherized if this be thought desirable; there should be a moderate quantity of liquid in the bladder, and therefore, if the patient have passed his urine shortly before the examination, a few ounces of tepid water may be injected through an elastic catheter.

FIG. 475.



Thompson's sound, with slide and scale, for ascertaining the magnitude of a stone. The handle, which resembles that of a modern lithotrite, but smaller, affords great facility in sounding.

The surgeon, standing between the thighs of the patient, or on either side,[1] and holding the sound, previously warmed and oiled, in his right hand, and in a horizontal direction, introduces the beak into the urethra, and, drawing the penis forward with the left hand, gradually elevates the shaft of the instrument, which passes in by its own weight, until from being horizontal it has assumed a vertical position; it is held thus for a few seconds while it traverses the membranous portion of the urethra, when by gently depressing the handle between the thighs, the beak rises through the prostatic portion into the bladder. In many cases the stone will be immediately touched by the sound, which then communicates a peculiar sensation to the hand of the surgeon, accompanied by a distinct noise or "click," which is commonly audible to the bystanders, and which may be intensified by attaching a small sounding-board to the handle of the instrument, or, as suggested by Head, of Dublin, and Andrews, of Chicago, by attaching a flexible tube, the other end of which is applied to the surgeon's ear.[2] In other instances, the stone will not be so easily discovered, and the surgeon must then cautiously search for it, turning the sound first on one side and then on the other, and varying the position of the handle so as to explore with the beak every portion of the bladder in succession; this is done with a kind of tapping motion, imparted by lightly rotating the instrument between the thumb and forefinger.

The stone will usually be found on one or other side of the neck of the bladder, or at the fundus of the organ near the orifices of the ureters; it may, however, in an adult, be lodged behind the prostate, or may rest above the pubis. To explore the former region, the position of the sound is reversed, the beak being turned downwards and the handle elevated, while the stone may be pushed upwards by means of the finger in the rectum; to find a stone above the pubis, the beak of the sound is tilted forwards while the handle is well depressed between the thighs, the bladder being at the same time pressed downwards by placing the hand over the lower part of the abdomen. Occasionally the position of the patient may be advantageously varied by placing a high pillow beneath the buttocks, or by causing him to lie on either side, to sit, or even to stand; or the bladder may be distended with water which is then allowed to escape slowly through the hollow sound, when, as the organ contracts, the stone will probably fall against the instrument. If the presence of the calculus is not determined in the course of five or ten minutes, the instrument should be withdrawn, and further exploration postponed for three or four days—prolonged sounding being attended with some risk of producing cystitis. After the use of the sound, it is better that the patient should keep pretty quiet, and, if there be any pain, an opium suppository may be introduced into the rectum.

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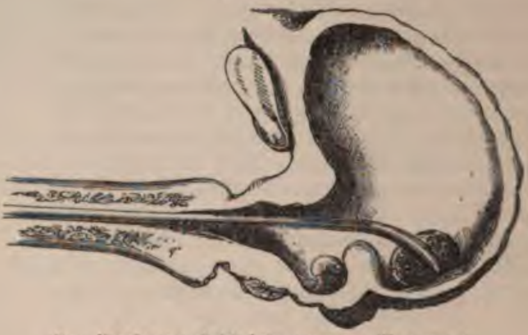
[1] The beginner may stand on the left side, as in catheterization, and cross over to the right side when the sound has reached the bladder, but, with a little practice, it will, I think, be found more convenient to stand on the right side, when no change of position will be required to enable the exploration of the bladder to be conducted with the right hand. Fergusson prefers to stand on the right side and introduce the instrument with the left hand. When it is desired to aid the diagnosis by means of the finger in the rectum, the surgeon should stand between the patient's thighs.

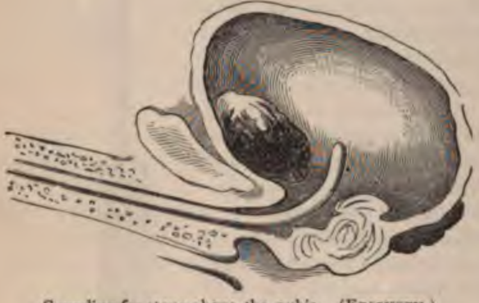
[2] Sir H. Thompson and Dr. H. M. Taylor, of Richmond, Va., have recently em-

FIG. 476.



Sounding for stone behind the prostate. (ERICHSEN.)

FIG. 477.



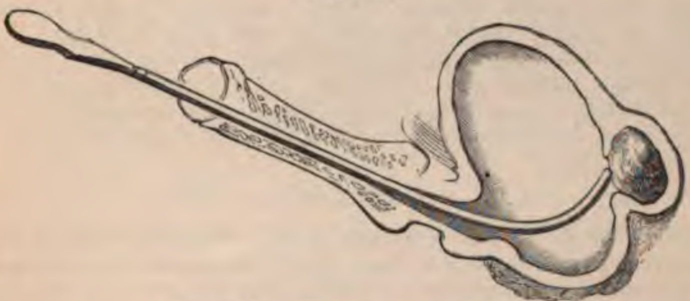
Sounding for stone above the pubis. (ERICHSEN.)

Beside determining merely the existence of a stone in the bladder, the surgeon may by sounding acquire valuable information as to the *number*, *size*, and *hardness* of the calculi, whether they be *adherent* or *encysted*, and as to the general *condition of the bladder and prostate*—all points of importance in regard to treatment. If the sound strike a stone on either side of the bladder, the surgeon knows that there is more than one calculus; but this can be better determined by the use of a light lithotrite, seizing one

ployed the *microphone* for the detection of small calculi. Von Brabandt recommends exploration with the canula of an aspirator, introduced above the pubis. Napier used a sound blackened by dipping it in a solution of nitrate of silver, the contact of the stone producing scratches on the surface.

stone and then using the instrument as a sound in searching for others. The lithotrite affords also the best means of ascertaining the size of a stone, though this may be done with approximate accuracy by moving the sound from side to side, or by touching the calculus first with the convex and then with the concave surface of the instrument. The hardness of the stone may be estimated by the character of the "click" produced by the contact of the instrument, a phosphatic concretion giving a dull thud, while a uric acid, and more especially an oxalate of lime, calculus gives a sound of a clear, ringing character. If the stone were invariably found in the same locality, no matter what the amount of liquid in the bladder nor what the position of the patient, the surgeon would suspect that the calculus was adherent; and if, in addition, the sound, while touching the stone but at one point, passed over a prominent swelling projecting into the bladder, the inference would naturally be that the calculus was encysted. The condition of the bladder, whether sacculated, ribbed, or incrusted with phosphatic deposits, and the size and relations of the prostate, can also be pretty accurately determined by exploration with the sound.

FIG. 478.



Sounding for encysted calculus. (ERICHSEN.)

A stone, though present, may escape detection, from its being encysted or lodged in one of the sacculi of the bladder, from being coated with blood or mucus, or even from its small size enabling it to slip away and elude the sound. Hence, in any case in which the rational symptoms indicate the presence of a calculus, though none can be found, the surgeon should repeat the exploration from time to time, varying the conditions under which the examination is conducted, until the diagnosis is rendered certain.

The surgeon may, on the other hand, think that he has detected a stone when none is present, being misled by striking the sound against a calculous incrustation, against a tumor in the bladder, or in the neighborhood of and compressing that organ, or even against the walls of the bony pelvis. That the possibility of these errors being made is not merely imaginary, is shown by the fact that such eminent lithotomists as Cheselden, Crosse, and Roux, each cut for stone (the former in three instances) in cases in which no stone could be found after the operation.

Sounding for Stone in Women is effected with a short and very slightly curved instrument, resembling in shape the ordinary female catheter. Great assistance may be derived from tilting forward the stone by means of two fingers introduced into the vagina.

Prognosis.—Stone in the bladder, unless removed by treatment, leads to serious morbid changes in the urinary organs, a fatal result being, sooner or later, almost inevitable. The prostate commonly becomes enlarged, and cystitis occurs, the bladder usually being contracted and ribbed, but sometimes dilated; congestion and ultimately granular degeneration of the kidneys follow, and the patient dies worn out by suffering, or from the progress of the renal affection. If, on the other hand, the presence of the stone be recognized at an early period, and proper treatment adopted before the viscera, and especially the kidney, have become seriously involved, the prognosis is quite favorable, lithotomy being an exceedingly successful operation in the case of children, and lithotrity (when not too long delayed) equally so in the case of adults.

Treatment of Vesical Calculus.—There are several modes of treatment employed in cases of vesical calculus, and each may be properly resorted to in suitable cases. That surgeon will do more to promote both the welfare of his patients and his own reputation, who, in the treatment of stone, varies his remedies in accordance with the particular circumstances of each individual case, than he who uniformly follows one exclusive mode of practice.

LITHOLYSIS.

Litholysis, or the *Solvent Treatment of Stone*, is unfortunately applicable to but a very limited number of cases. In the management of *renal calculus*, as already mentioned, a trial of the plan is often proper, for there is nothing else to be done; but, in dealing with stone in the bladder, the surgeon has no right to waste time and deprive his patients of the great advantages to be derived from an early operation, by resorting to a mode of treatment which is at best slow and uncertain. There are cases, however, in which the solvent treatment may be proper. Thus, as an *adjuvant to lithotrity*, in the case of a *uric acid* (or *cystine*) calculus, advantage may be sometimes gained from the administration of the citrate or acetate of potassium in the way already mentioned, so as to keep the urine moderately alkaline, *provided that there be no tendency to ammoniacal decomposition.* If the urine be ammoniacal, the alkaline treatment is positively contra-indicated. In dealing with *phosphatic* calculi, injections of dilute nitric acid (Ac. nitric. dilut. (U. S. P.) fʒij, Aquæ Oj.) may be employed, as an adjuvant to lithotrity (as has been done by Southam, Harrison, and Richardson), or alone, when the general condition of the patient forbids operative interference, as in the well-known case recorded by Sir Benjamin C. Brodie. A similar mode of treatment, under the name of *lithoclysmy*, has been recently advocated by Dr. Pignoni. Injections of acetate of lead (gr. j to f℥iij) and of hydrochloric acid (♏j–ij to f℥j) are favorably spoken of by Sir Henry Thompson. *Oxalate of lime* calculi do not appear to be amenable to any form of solvent treatment.

LITHOTRITY.

Lithotrity, or the operation of *Crushing a Stone in the Bladder*, is now generally, and in my opinion justly, considered the best mode of treatment for any case of vesical calculus to which it is applicable. The first formal proposition to treat calculus in this manner is usually attributed to Gruithuisen, a Bavarian surgeon, who wrote in the year 1813; but a claim of priority has been advanced, and upon apparently good grounds, for two Italian surgeons named Santorio and Ciucci, who flourished in the seventeenth century.[1] However this may be, it is to Civiale that is unquestionably due the credit of giving the operation a place among the recognized procedures of practical surgery, his first operation upon the living subject having been done in the year 1824. Since then lithotrity has been very frequently practised in France and England, and to a certain extent in our own country; and the instruments employed have been brought to a high degree of perfection, chiefly through the labors of Civiale, Fergusson, and Thompson, aided by the well-known manufacturers, Charrière, Matthews, Coxeter, and Weiss. Two instruments are usually required: one with the female blade fenestrated, for crushing stones or large fragments, and one with both blades plain, for reducing the smaller fragments to powder; the plain-bladed lithotrite is often though incorrectly called the scoop, and is now used by Thompson almost to the entire exclusion of the fenestrated instrument. The *blades* of the lithotrite are rather wider than the *shafts*[1] (which should be as light and slender as may be compatible with sufficient strength), and the male blade should be narrower than the female. The shaft and blades, which are united at an angle of 110°–120°, should be cut out of solid pieces of steel, as they will thus fit more accurately and be much stronger than when bent into shape from flat plates of metal. The handle of Weiss and Thompson's improved lithotrite (Fig. 479), which is probably the best now before the profession, is in the form of a grooved cylinder, the force being applied by means of a screw, and the handle being furnished with a button, which by an ingenious mechanism enables the screwing to be instantly converted into a sliding motion, and *vice versâ*. In Fergusson's instrument the force is applied by means of a rack and pinion. Amussat employs a lithotrite (or *lithoclast*) in which a certain amount of lateral motion can be given to the male blade, thus rendering it more easy to free the instrument from calculous detritus. Prof. Bigelow employs a very powerful lithotrite with a tube or groove between the blades, for the injection of water without removing the instrument.

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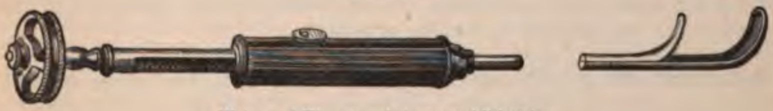
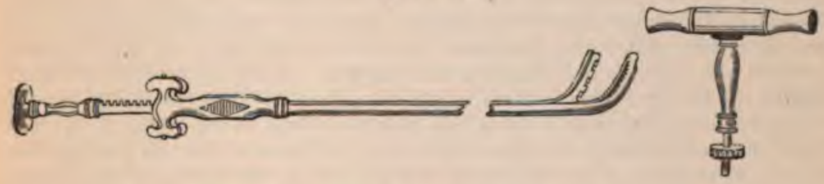
[1] Brit. and For. Med. Review, vol. xi., Jan. 1841, p. 270.

FIG. 479.



Weiss and Thompson's improved lithotrite.

FIG. 480.



Fergusson's lithotrite; the male blade is moved by a key.

Preparatory Treatment.—For a few days, at least, before submitting a patient to lithotrity, the surgeon should enjoin rest in a recumbent position, and should adopt suitable means to bring the digestive system into a good condition, and to combat any vesical irritation that may exist, by the use of hip baths, anodynes, demulcents, etc. Sir H. Thompson speaks very highly of a decoction of the *triticum repens*, or couch-grass, of which he directs a pint to be taken in divided doses in the course of the day. The use of an exclusive milk-diet is recommended by Dr. George Johnson and by Dr. S. Weir Mitchell, of this city. The urethra may also be accustomed to the use of instruments by the introduction first of elastic, and subsequently of metallic, bougies of gradually increasing sizes, and, finally, of an ordinary sound with which the stone may be touched and some notion gained of its size and composition. If the introduction of instruments produces great constitutional disturbance, the operation should be postponed for a short time, until the irritable condition of the urethra has been overcome; and if this cannot be done, the surgeon may be induced by this circumstance alone to abandon crushing and resort to lithotomy. The urine should be examined, and if it contain much mucus or pus, the bladder may be washed out (through a flexible catheter) with simple injections of tepid water, which may be replaced by a very weak solution of nitric acid, if there be a copious deposit of phosphates. The conditions wished for and sought to be obtained by preparatory treatment are, according to Thompson, (1) a fairly capacious and not very tender urethra; (2) a bladder capable of retaining three or four ounces of urine, not very irritable, and yet with sufficient tone to be able to expel its contents; and (3) fair general health. With these conditions and a stone of but moderate size and hardness, the operation of lithotrity offers an exceedingly favorable prognosis.

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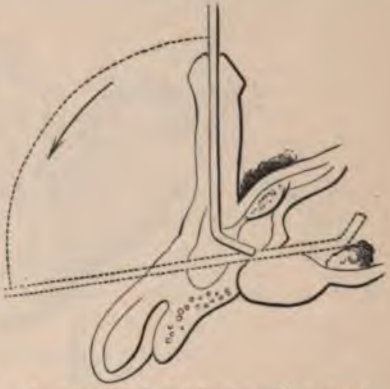
[1] The shaft attached to the male blade is technically called the sliding rod.

Operation.—Some difference of opinion exists as to the propriety of employing anæsthetics in lithotrity. If performed with skill and delicacy, the operation is attended with little or no pain, and anæsthesia is therefore not required unless in exceptional cases. There is, moreover, a certain advantage in operating without ether, in that the surgeon can thus judge of the irritability of the bladder, and extend or abridge the duration of the "sitting" accordingly. The operation itself may be described as occupying three stages, viz., (1) the introduction of the lithotrite, (2) the seizing, and (3) the crushing of the stone. The patient should lie on his back on a firm mattress, with his right side close to the edge of the bed, and the hips slightly elevated; the thighs should be slightly flexed and supported upon pillows, and should be sufficiently separated to allow the free play of the lithotrite between them, the knees being for this purpose kept at least twelve inches apart. If the prostate be much enlarged, a firm cushion should be placed beneath the pelvis, so as to raise this part from four to six inches above the level of the shoulders; the stone thus rolls backwards from its position behind the prostate, and comes more readily within the grasp of the instrument. If the patient has passed his urine within half an hour of the time fixed for operating, three or four ounces of tepid water may be slowly injected through a flexible catheter; but this is not usually necessary, and the preliminary catheterization is in itself undesirable, as prolonging the sitting.

Introduction of the Lithotrite.—The surgeon, standing on the *right side* of the patient, holds the lithotrite, previously warmed and well oiled, lightly in his right hand, in a horizontal line, and in a direction nearly parallel to the long axis of the patient's body. The left hand raises the penis, and slowly draws the urethra upwards over the blades of the instrument, which is allowed to enter by its own weight as it is gradually raised into a vertical line. The lithotrite thus reaches the bulbous portion of the urethra, and must then be held vertically for a few seconds, until the membranous portion has been traversed, when, by gently depressing the handle between the patient's thighs, the blades of the instrument slowly rise through the prostatic portion of the canal into the bladder. Sir H. Thompson advises that at this time a slight lateral rotatory movement should be given to the lithotrite, and that the surgeon should press over the pubes, so as to relax the triangular ligament of the penis. As the instrument enters the bladder, its shafts form an angle of 20° or 30° with a horizontal plane, and when the introduction is completed, the urethra loses its curve and is brought into a straight line.

FIG. 481.



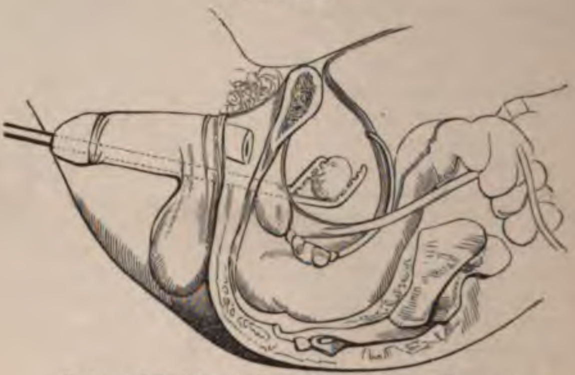
Introduction of the lithotrite. (ERICHSEN.)

Finding and Seizing the Stone.—There are two ways in which this may be done. Heurteloup's plan, which was followed by Brodie, and which has been usually adopted in England, was to depress the base of the bladder with the angle or convexity of the lithotrite, and then, drawing back the male blade, give the instrument a tap or jerk, so as to cause the calculus to fall within its grasp. The other method, which originated with Civiale, is adopted by Thompson, and seems to me the best. In this method the blades of the lithotrite are passed to about the centre of the bladder, the handle (which is attached to the female blade) being lightly held in the left hand, while the sliding-rod is worked with the right. If, as often happens, the stone is touched by the instrument as it enters the bladder, the blades are slightly inclined in the opposite direction, the male blade gently withdrawn, and the opened blades then inclined towards the stone, which is readily caught between them when the lithotrite is closed. Under other circumstances, the instrument is made to go in search of the calculus, by opening the blades in the centre of the bladder, turning them to the right, and closing; opening them again in the centre, turning to the left, and closing; then repeating the same movements with the handle of the lithotrite depressed, and so on until, if necessary, the whole cavity of the bladder has been explored. During the rotation of the blades the handle of the lithotrite is held steadily with the left hand, so that the shaft, which is in contact with the urethra and neck of the bladder, shall have no motion except upon its own axis, while the blades are inclined in various directions by the rotatory movement imparted by the right hand, and greatly facilitated in Thompson's instrument by the cylindrical shape of the handle. The following formula is given by Thompson as expressing the different directions in which the blades of the instrument are to be made to seek for the calculus: Vertical, right and left incline, right and left horizontal, and (if the prostate be enlarged) right and left reversed incline, and reversed vertical. For the reversed exploration a short-bladed lithotrite is preferred.

In the description given above, the female blade is supposed to be fixed, and the jaws of the lithotrite to be opened by drawing the male blade backwards, but it is often found convenient in practice to fix the male blade and open the instrument by projecting the female blade.

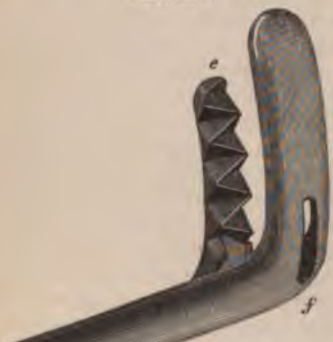
Crushing the Stone.—When the calculus has been seized, the surgeon rotates the lithotrite a little, to make sure that none of the vesical mucous membrane is included in its grasp, and then fixes it by drawing up the button attached to the handle of the instrument, which changes the sliding into the screwing action; the stone, being now held firmly in the centre of the bladder, the screw is to be turned slowly until the resistance yields, which it will do gradually or suddenly, according to the consistence of the calculus. The male blade is then to be drawn out (the screwing being for this purpose reconverted into the sliding motion), when, without altering in any respect the direction of the instrument, one of the fragments may be picked up and crushed as before; and this process may, under favorable circumstances, be repeated two or three times. The instrument is then accurately closed and slowly drawn out by reversing the steps by which it was introduced. It is better not to attempt too much at the first sitting, and Thompson's rule is that the lithotrite should not remain in the bladder more than two minutes, or, if the patient be anæsthetized, about ten minutes. In the first sitting it is sufficient to *crush* the stone (which, if the calculus be large, is best done with the fenestrated lithotrite), the *pulverization* of fragments being left for subsequent occasions. The sittings, if all go well, may be repeated at intervals of from three to six days.

FIG. 482.



Position of the lithotrite in crushing the stone. (LISTON.)

FIG. 483.

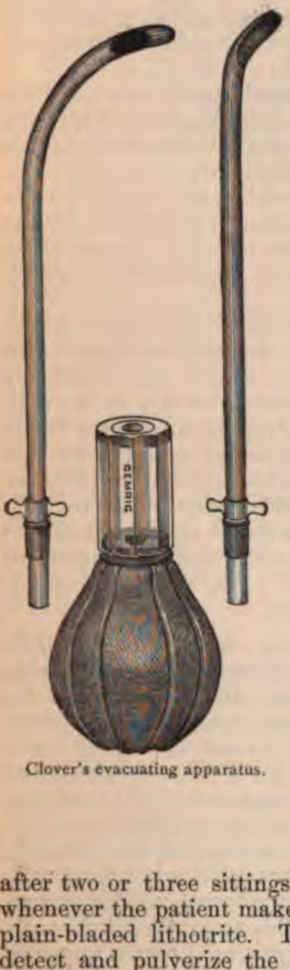


Bigelow's lithotrite. *e*. Male blade, presenting, on alternate sides, triangular notches. The small portion of débris not discharged laterally by these notches is driven through the slot in the female blade. *f*. Slot in the female blade.

Rapid Lithotrity with Evacuation (**Litholapaxy**).—The operation above described is the ordinary lithotrity, as perfected by Civiale, Fergusson, and Thompson. Prof. Bigelow, of Boston, has, however, advised that the whole operation should be completed at one sitting, which he does not hesitate to prolong to three or four hours. He has devised special instruments for crushing the stone and evacuating the fragments, and has published a number of cases in which his operation, which he calls *litholapaxy*, has been successfully performed. Successful operations by this method have since been reported by Van Buren and Keyes, of New York, Thompson, Coulson, Stokes, of Dublin, and many other surgeons.

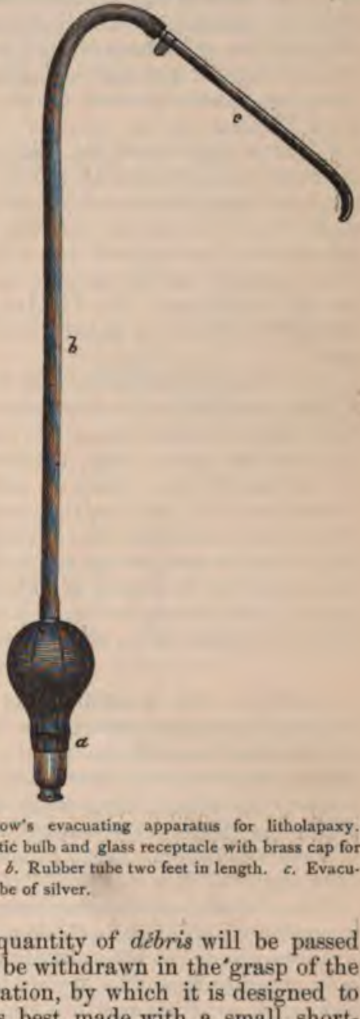
After-treatment.—For at least twenty-four or thirty-six hours after each of the earlier sittings the patient should lie in bed, and particularly avoid passing water except in the recumbent posture, so as to prevent angular fragments from falling upon the neck of the bladder or becoming impacted in the urethra. He should be warmly wrapt up, and a hot napkin or poultice may be applied over the pubes and perineum, an opium and belladonna suppository being at the same time introduced into the rectum. The sharp corners of the fragments are soon worn off by the contact of the urine, and after two or three sittings a considerable quantity of *débris* will be passed whenever the patient makes water, or may be withdrawn in the grasp of the plain-bladed lithotrite. The final exploration, by which it is designed to detect and pulverize the last fragment, is best made with a small, short-bladed lithotrite, which is successively directed to all parts of the bladder, and particularly to the pouch behind the prostate. As a test of the complete removal of the calculus, W. J. Coulson advises that the patient should take a drive over a rough road, when, if any fragment remain, its presence

FIG. 484.



Clover's evacuating apparatus.

FIG. 485.



Bigelow's evacuating apparatus for litholapaxy. *a*. Elastic bulb and glass receptacle with brass cap for débris. *b*. Rubber tube two feet in length. *c*. Evacuating tube of silver.

will be revealed by the irritation produced by the jolting. Mr. Napier employs, for the final exploration, an "indicator" tipped with blackened lead, and Dr. S. C. Duncan a nickel-plated sound coated with lamp-black and collodion: contact with calcareous matter, in either case, scrapes off the coating, and restores the natural color of the instrument.

Washing out the Bladder.—In ordinary cases it is probably wiser, as advised by Thompson, for the surgeon to content himself with breaking up the stone, leaving the extrusion of detritus to the unaided efforts of nature; but in some instances, as for example, if there be enlargement of the prostate with retention of urine, it is necessary to adopt artificial means to accomplish this object. In some cases it will be sufficient to use an "evacuating catheter," provided with a large eye near its extremity, through which the *débris* of the stone may escape,[1] but in other cases it will be better to wash out the bladder through a double catheter, or to employ one of the ingenious instruments devised for the purpose by Mr. Clover, Prof. Dittel, and Prof. Bigelow.

Clover's apparatus (Fig. 484) consists of an elastic bottle, with a glass reservoir, and evacuating tubes of different sizes and shapes; the bottle is filled with tepid water which is slowly injected into the bladder, bringing with it as it returns the detritus, which is detained in the reservoir. The process may be repeated 10 or 12 times at each sitting, with great gentleness, however, lest the mucous membrane of the bladder be injured by the eye of the catheter. Dr. Gouley, of New York, has recently suggested that the bottle of Clover's apparatus may be conveniently replaced by an aspirator.

Prof. Dittel, of Vienna, has suggested an ingenious application of the siphon principle to the evacuation of detritus after lithotrity, and his instrument appears to me even better than that of Clover; the evacuating catheter is connected with a long, flexible siphon tube which reaches to a vessel placed on the floor, while an arrangement of valves permits water to be thrown into the bladder, the outward current depending upon the force of atmospheric pressure; the advantages of this method are that the bladder can be more completely emptied than by any other plan, while there is comparatively little risk of inflicting injury upon the vesical mucous membrane. The siphon principle is also employed in the evacuating apparatus of Prof. Bigelow (Fig. 485).

Accidents and Complications of Lithotrity.—If the lithotrite be properly employed, there can be no danger of lacerating the urethra or injuring the mucous lining of the bladder; it has happened that the *instrument has broken* in attempting to crush a hard calculus, and should such an unfortunate event occur, there would be no alternative to cutting into the neck of the bladder and extracting the foreign body. To prevent the possibility of such an accident, every lithotrite should be tested before it is used, by crushing with it a lump of sandstone about the size of an English walnut.

One of the most annoying complications which can be met with after the operation of lithotrity, is the *impaction of a fragment of calculus in the urethra*—an accident which is usually traceable to the restlessness of the patient, and particularly to the neglect to keep the recumbent posture when urinating. Apart from the pain and local irritation produced by the impacted fragment (which may cause cystitis, or abscess in the neighborhood of the urethra, leading perhaps to urinary extravasation), there is often great constitutional disturbance, with repeated rigors and possibly the development of a pyæmic condition. The course to be pursued in the event of impaction occurring, varies according to the point at which the fragment has been arrested: should this be in front of the membranous portion of the urethra, the offending body should be extracted through the external meatus with delicate urethral forceps, such as Mathieu's (Fig. 486), with a curette, or with Civiale's scoop; while if lodged in the prostatic or membranous portion, it should be pushed back into the bladder with a full-sized bougie or a stream of water directed through a catheter with an open end, or, if these means fail, should be removed through an incision in the median line of the perineum; under these circumstances, it might be well to convert the operation into what has been named by Dolbeau, *perineal lithotrity*, reducing the remaining fragments to a sufficient size to enable them to be extracted through the wound.

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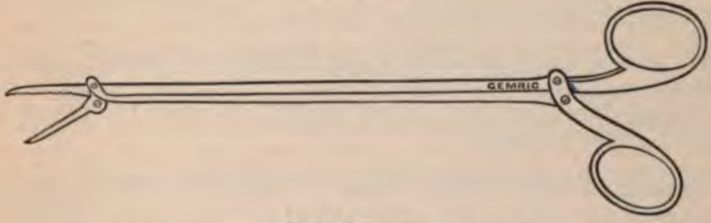
[1] After the earlier sittings these means of artificial evacuation should not be employed, for there is then no fine *débris* to be washed out. If retention exist, the urine may be drawn off with an ordinary catheter.

Other complications of lithotrity (which, however, are not peculiar to this operation, but may follow the use of a simple bougie or catheter) are *urethral fever, hæmaturia*, and *inflammation of the bladder, prostate*, or *testis:* these will be considered hereafter. *Retention of urine* is another complication which not unfrequently occurs, particularly in old persons, and which, on account of the insidious manner in which it is developed, should be carefully watched for; here, as in other cases, the true condition is masked by apparent incontinence; the treatment consists in using the catheter at regular intervals, until the natural tone of the bladder is restored.

FIG. 486.



Urethral Forceps.

Statistics of Lithotrity.—The statistical results of lithotrity, in the hands of any operator, will necessarily vary very much according to the good or bad judgment which he exercises in the selection of his cases, and, as justly remarked by Sir Henry Thompson, unless the surgeon can arrive at an accurate diagnosis of the nature and size of the stone (and, I may add, of the condition of the urinary organs of his patient), it is probably safer to avoid lithotrity entirely, and uniformly resort to lithotomy. But if an accurate diagnosis can be made, the risk to life, in suitable cases, is, I think, certainly less (in the case of an adult) if the stone be crushed than if it be removed by cutting: to establish this, it will be sufficient to refer to the experience of those surgeons who have practised the operation most frequently, and who may therefore be supposed to have brought it to its highest state of perfection. Omitting Civiale's cases (the record of which is considered inaccurate by many of those best qualified to form an opinion on the subject), the experience in lithotrity upon male adults of Brodie, Fergusson, Keith, Thompson, and Cadge, may be summed up in the following table:—

Brodie	115 cases,	9 deaths, or	7.83 per cent.
Fergusson	109 "	12 "	11 "
Keith (of Aberdeen)	116 "	7 "	6.03 "
Thompson	422 "	32 "	7.58 "
Cadge	86 "	8 "	9.30 "
Aggregate	848 "	68 "	8.02 "

These results, it will be seen, are very satisfactory; they cannot, of course, be in any way compared with the results of lithotomy—and still less with those of lithotomy since the introduction of the crushing method; for lithotrity is now confessedly chosen for the most favorable, and lithotomy for the least favorable, cases. An approximate judgment as to the actual benefits derived from the introduction of lithotrity, may, however, be arrived at by comparing the mortality in *all* cases of stone submitted to operation by those who practise *both* methods, with that of cases in the hands of surgeons who employ lithotomy only: from such a comparison it appears that the death-rate, in cases of adult males, is reduced nearly six per cent. by the adoption of the former course:—

1215 cases operated on by both methods, by Fergusson, Keith, Thompson, and Cadge, gave 180 deaths, or 14.81 per cent.
799 cases operated on by lithotomy exclusively, collected by Thompson, gave 161 deaths, or 20.15 per cent.

It is thus seen that a considerable gain is derived by resorting to lithotrity in suitable cases; and it is surely, therefore, the surgeon's duty to employ the crushing rather than the cutting method, whenever the former is not positively contra-indicated.

Circumstances which forbid a Resort to Lithotrity.—These have regard to the age of the patient, the nature and size of the stone, the condition of the urinary organs, and the state of the patient's general health.

1. *Age.*—In the first place, lithotrity is contra-indicated in the treatment of children *below the age of puberty:* the grounds for this assertion are that (1) the *urethra* is too small at this age to permit the free play of an instrument of sufficient strength; (2) the *bladder* is placed so high—in the abdomen rather than in the pelvis—as to render the use of the lithotrite difficult and not very safe; (3) children do not bear with impunity the frequent *repetition of operations* required in the various sittings of lithotrity; (4) the operation can scarcely be performed in children without the aid of *anæsthesia* (which is in itself undesirable); and (5) *lithotomy* is such a successful procedure in early life as to render it difficult for any other mode of treatment to compete with it. I know of no extended statistics of *lithotrity* in children, but Guersant reports 40 cases (5 of them, however, in girls), with 7 deaths, or a mortality of 17½ per cent. Several cases, moreover, required subsequent lithotomy. His *lithotomies* number 100, with 14 deaths, and his total number of cases, treated by both methods, 140, with 21 deaths, or a mortality of 15 per cent. Thus, even in his own hands, lithotrity (in children) has been less successful than lithotomy, while the results of the latter operation, when indiscriminately applied to all cases under puberty, have been still more favorable, 1028 cases collected by Thompson giving but 68 deaths, or a mortality of less than 7 per cent. Comparing these figures with those given in the preceding pages, we find that *indiscriminate lithotomy, in children, is safer even than lithotrity, in selected cases in adults; and that, on the other hand, lithotrity, in selected cases in children, is not much less dangerous than indiscriminate lithotomy in adults.* Hence, the inference

seems to me inevitable, that an age below puberty is a positive contra-indication to lithotrity.

2. *Nature and Size of the Stone.*—No absolute rule can be laid down upon these points, but it may be said, in general terms, that in the case of *hard* calculi (as of oxalate of lime), *one inch* is the maximum diameter which admits of crushing, and for lithotrity to be properly applied to a mulberry calculus of this size, all the other circumstances of the case should be favorable; in the case of uric acid, and particularly of phosphatic calculi, this limit may be somewhat exceeded, but even in dealing with such stones, if more than an inch and a half in diameter, lithotomy will usually be a safer operation than lithotrity. Two inches would be the maximum, even if the calculus were phosphatic and the bladder healthy—a combination of circumstances which is not very likely to occur. The existence of *multiple calculi* is in itself no contra-indication to lithotrity; on the contrary, if, as then usually happens, the calculi be small, the operation of crushing may be considered as having been partially accomplished by nature; if, however, the stones be numerous and large, lithotomy would undoubtedly be a safer procedure. If the calculus be *adherent* or *encysted*, lithotrity is, of course, out of the question.

3. *Condition of the Urinary Organs.*—Several circumstances require consideration under this head.

(1.) *Stricture of the Urethra* is almost always a contra-indication to lithotrity, though Sir Henry Thompson has shown that the crushing operation may occasionally be successfully resorted to in these cases, the stricture being of course submitted to dilatation as a preliminary measure; in the large majority of instances, however, and certainly in the hands of the majority of operators, lithotomy either by the lateral or median method, according to the size of the stone, would be a preferable procedure in cases of this kind.

(2.) *Enlargement of the Prostate* is not in itself a contra-indication to lithotrity, though it renders the operation more difficult, and requires the use of Clover's apparatus or some similar contrivance to aid in the evacuation of detritus; if, however, the enlargement be complicated with an irritable condition of the bladder, lithotomy should be preferred, particularly if the calculus be of considerable size.

(3.) *Atony, or Paralysis of the Bladder*, is usually thought to contra-indicate lithotrity, but does not, in the judgment of Sir H. Thompson, whose opinion upon this point is entitled to great respect. If, however, the stone be large, in a case of atony of the bladder, the crushing operation should probably not be performed.

(4.) *A Sacculated Condition of the Bladder*, if it could be detected beforehand, would ordinarily contra-indicate lithotrity, on account of the probability of fragments becoming lodged in the sacculi, where they would produce irritation, and might elude the efforts of the surgeon to find and dispose of them. It is possible, however, that by using Dittel's siphon arrangement, much of this difficulty might be avoided.

(5.) *Cystitis*, if present in an aggravated degree, may be a bar to the performance of lithotrity. If the urine be loaded with mucus, or, still worse, with pus, and the introduction of the sound be productive of great pain and irritation, lithotomy will usually be the better operation. If, however, the stone be small and friable, an attempt may be made to lessen the irritability of the bladder by keeping the patient in bed and daily injecting tepid water, as advised by Brodie, when, if this plan succeeds, lithotrity may perhaps be safely resorted to. When cystitis occurs during treatment by lithotrity, Thompson advises that the patient should be etherized, the fragments of stone freely crushed, and the *débris* evacuated by means of Clover's apparatus.

(6.) *Malignant Disease of the Bladder* would certainly diminish the chances of successful lithotrity, but would still more positively contra-indicate lithotomy; if the stone in such a case were friable and of moderate size, it would, I think, be justifiable to crush it, merely as a palliative measure.

(7.) *Organic Disease of the Kidney,* as evidenced by the presence of albumen and tube-casts in the urine, is usually considered to contra-indicate the performance of lithotrity. It undoubtedly renders the prognosis of the case very gloomy, and it is even a question whether any operation should be performed under these circumstances. If in any case of this kind it be determined to attempt the removal of the stone, and the surgeon has to choose between lithotrity and lithotomy, his decision should, I think, be chiefly guided by the character of the calculus; if this be such that the bladder can probably be cleared in one or two sittings, the crushing operation should be preferred; but under opposite circumstances, lithotomy would be the safer procedure.

(8.) *A Tendency to the Development of Urethral Fever* is, I think, a positive contra-indication to lithotrity; if the surgeon finds that a rigor, with subsequent febrile disturbance, follows every introduction of an instrument into the bladder (and this can be tested by the preliminary use of bougies), all idea of crushing the calculus had better be abandoned, and lithotomy resorted to instead. If lithotomy be persisted in under these circumstances, the operation will not improbably be followed by deep-seated suppuration, pyæmia, and perhaps death.

4. *General Condition of the Patient.*—If the health of the patient be feeble, and his strength failing, without there being any special disease of the urinary organs, lithotrity is unquestionably preferable to lithotomy, and should be performed if the size of the stone permits. This condition is not unfrequently met with in old people, whose constitutional powers seem to have deteriorated, without any particular lesion being present to account for the change. If, on the other hand, the patient be of a nervous, anxious, and irritable disposition, the length of time which the successive sittings of lithotrity necessarily occupy constitutes in itself an objection to the operation, and in a doubtful case may serve to turn the scale in favor of lithotomy, which rids the patient at once of the source of his discomfort.

LITHOTOMY.

Lithotomy, or the operation of *Cutting into the Bladder to Extract a Stone,* is the remaining resource in all cases (among patients of the male sex) not admitting of lithotrity; it is, therefore, the mode of treatment to be adopted in all cases below the age of puberty, and in a certain proportion, variously estimated by authors at from one-half to one-sixth, of the remainder; hence every surgeon who sees a fair proportion of both youthful and adult patients, will have to cut at least twice for each time that he crushes once.

It is not my intention to give any account of the *history* of lithotomy, for which I would refer the student to the works of John Bell, but to describe the principal operative procedures which are in use at the present day, beginning with the ordinary *lateral* method, which is essentially that introduced by Cheselden, and considering subsequently the *median, bilateral,* and other forms of operation, and the circumstances by which, in my judgment, each is specially indicated.

Preparatory Treatment.—It is seldom, if ever, that there is any necessity for an *immediate* resort to lithotomy; but, on the contrary, there is usually ample time for the surgeon to satisfy himself, by careful and repeated sounding, and by chemical and microscopical examination of the urine, as to the nature, size, and relations of the calculus, the condition of the urinary organs, and any other points which it may be necessary to investigate, in order to form a correct judgment as to the state of his patient. An important question, which occasionally arises in practice, is whether the surgeon should operate in every case, provided that the patient desire it—giving him the "ghost of a chance," as it is sometimes called—or whether the operation should be declined whenever the surgeon's experience and judgment lead him to believe that operative interference can be productive of no benefit. The latter course is, I think, the one to be pursued; the case is very different from that of amputation for injury, or herniotomy, or colotomy for imperforate rectum, or even tracheotomy for croup. In those cases the patient is in imminent danger, and the operation, even if it do not avert, will at least not hasten death; but in lithotomy, as in ovariotomy, in the excision of tumors from the parotid region, and in other operations for diseases not attended with immediate risk, if the surgeon's interference do not cure, it will certainly kill; hence, in any case of vesical calculus, if, after careful examination and deliberate reflection, the surgeon comes to the conclusion that the patient will, in all human probability, not survive the operation, that operation should, in my judgment, be positively declined.

Fortunately this contingency is of rare occurrence, and it is almost always possible (unless the case be complicated by far advanced renal disease) to bring the patient into a fit state for operation, by enforcing rest for a week or ten days previously, and by adopting means to bring the digestive functions into a good state, and to lessen or relieve any existing irritation of the urinary organs (see page 893). A full dose of castor oil should be given on the previous day, and a simple enema a short time before the operation, so that the awkward accident of the patient's defecating over the surgeon's hand may be avoided, and that the rectum, being empty, may be less exposed to the risk of being wounded. It is well also, in the case of an adult, to have the perineum shaved before the patient is brought under the influence of the anæsthetic.

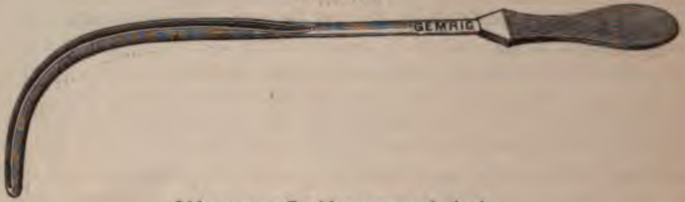
LATERAL LITHOTOMY.

For the performance of lateral lithotomy a firm *operating table* is required, of rather less than the ordinary height, so that when the surgeon kneels or sits before it his breast shall be about on a level with the patient's buttocks. Four *assistants* are required—one to hold the staff, one to give the anæsthetic, and two to fix the patient's limbs, one on either side. Many operators prefer to have a fifth assistant to hand the instruments, but if the surgeon adopt the kneeling posture (which I think the best), the instruments may be conveniently placed within his own reach, on a tray upon the floor.

Instruments.—The instruments required are a staff, a simple straight bistoury or scalpel, of a size proportioned to the age of the patient, a probe-pointed knife, two or three pairs of forceps, a scoop, and a large long-nozzled syringe. It is well, in addition, to have within reach a blunt gorget, a searcher, and a lithotomy tube.

The *staff* should be boldly curved, and of as large a size as the urethra will admit. It should have a deep and smoothly-finished groove on the left side, or (which I prefer) in the middle line of its convexity, beginning two or three inches above the commencement of the curve, and terminating abruptly in a right angle about a quarter of an inch from the extremity of the instrument. In using the common staff, the groove of which becomes gradually shallower, till it ends on the surface, there is great risk of the knife slipping off and wounding the posterior wall of the bladder. The handle of the staff should be broad and roughened, so as to give the assistant who holds it a firm grasp of the instrument.

Fig. 487.

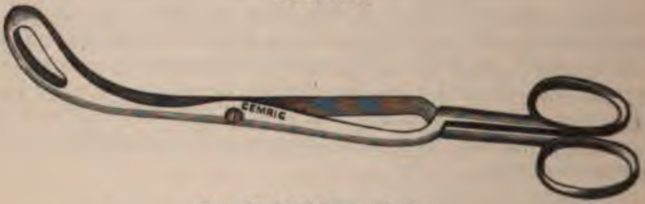


Lithotomy staff, with groove on the back.

The particular form of the *knives* used in lithotomy, may vary with the fancy of the operator. Almost every distinguished lithotomist has devised some special form of instrument, which bears his name, but, for my own part, I do not know of any which is better than the common straight bistoury, which is found in every "minor operating-case." The *probe-pointed knife* is useful in case it is found necessary to enlarge the incision after the withdrawal of the staff.

The *forceps* should be of various sizes and shapes, some straight and some curved. It is better, I think, to have the blades fenestrated, which gives more room and diminishes the weight of the instrument, and the blades may be lined with linen (as advised by Liston), thus allowing extraction to be effected without the application of so much force as to endanger the crushing of the calculus.

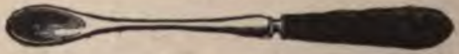
Fig. 488.



Open-bladed lithotomy forceps.

The *scoop*, well curved and of a moderate size, should be firmly fixed in a roughened handle, to prevent its slipping.

Fig. 489.

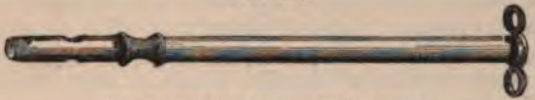


Lithotomy scoop.

The *syringe* should have a capacity of at least half a pint, and may be made of gutta-percha or of metal.

The *blunt gorget*, which is often combined with the scoop, should be probe-pointed, and is used to guide the introduction of the forceps when the perineum is too deep for the finger to reach the bladder. The *searcher* is merely a sound of slight curve, while the *tube*, which is introduced through the wound in case of hemorrhage, may be made either of silver, or of gum-elastic,

FIG. 490.

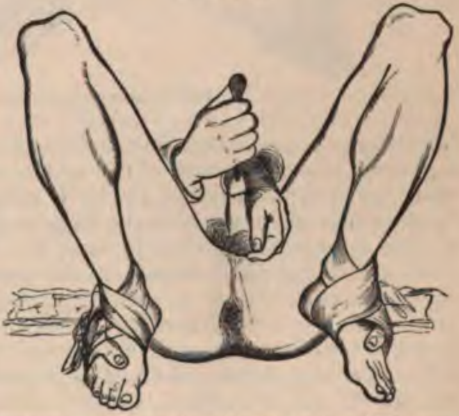


Tube for plugging the wound in lithotomy.

and should be rounded at the end, with large, laterally-placed eyes, and rings at the outer extremity to admit the tapes by which it is held in place.

Operation.—The operation is thus performed: The patient being thoroughly etherized (with his rectum empty, and his perineum shaved), the surgeon usually injects a few ounces of tepid water into the bladder (though this is not absolutely necessary), and then introduces the staff, with which, used as a sound, he should recognize the presence of the stone. If this cannot be done, the staff is withdrawn and an ordinary sound introduced, when, if the stone still cannot be found, the operation must be postponed. This is a well-established rule of surgery, and should be inflexibly adhered to; for (1) the stone, if small, may have been spontaneously evacuated upon some occasion of the patient's passing water; (2) it may have become caught in some pouch or sac of the bladder, from which it cannot be dislodged; or (3) the instruments may not have entered the bladder at all, but may have gone through some false passage into the recto-vesical space; under any of which circumstances the operation, if persisted in, could but result in injury to the patient and in the utter discomfiture to the operator. It is safer, indeed, unless the surgeon's skill should enable him to be sure that the staff is actually in the bladder, not to proceed with the operation unless the stone can be touched with this instrument, as well as with the sound.

FIG. 491.

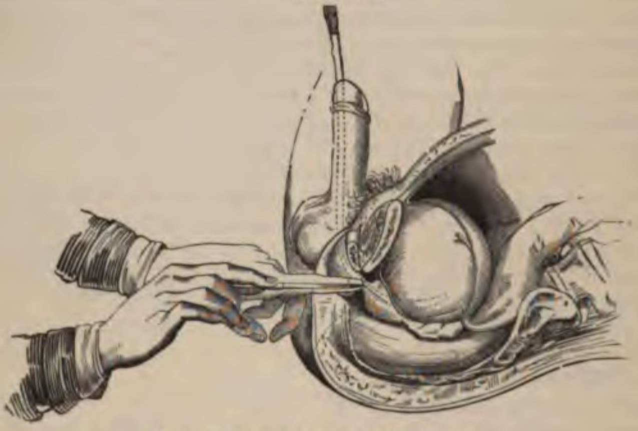


Position of patient and line of incision in lateral lithotomy. (ERICHSEN.)

The staff having been introduced, the patient is brought to the foot of the table, with his buttocks projecting over the end, and is secured in the "lithotomy position" by fastening together his hands and feet with bandages, or with leather straps provided for the purpose. Assistants then take charge of the limbs on either side, and expose the perineum by drawing the thighs outwards and backwards. The surgeon now fixes the staff in the way in which he wishes it to be held, and intrusts it to an assistant, who, standing on the patient's *left* side, holds it firmly in his *right* hand, while with the left he draws aside the patient's scrotum. It is this assistant's duty to keep the staff exactly as the operator has fixed it, until he is directed to withdraw it from the bladder. There are two ways in which the staff may be fixed. Liston's plan, which I think much the best, was to hook the staff firmly under the pubic arch, and draw it almost vertically upwards, and exactly in the median line, thus obtaining a *point* *d'appui* which insures the steadiness of the instrument, and widening the space between the urethra and the rectum. Many surgeons, however, believe that the operation is rendered easier by turning the staff a little to the left, and by making its convexity bulge into the perineum.

The surgeon now, casting a glance to see that all his instruments are in readiness, sits, or, which I much prefer, kneels on his right knee before the patient, and introduces a finger into the rectum, so as to insure the contraction of this tube, and, at the same time, fix in his mind the relative positions of the staff, prostate, rectum, and tuber ischii. Holding the knife lightly but firmly as a pen between the fore and middle fingers and thumb of the right hand, he now begins his incision a little to the left of the raphe and (according to the size of the perineum) from an inch to an inch and a half in front of the anus, and cuts obliquely downwards and outwards to a point below and between the anus and tuberosity of the ischium, but rather nearer the latter than the former. This incision should divide the skin and superficial fascia and fat, and should be rather deeper below than above; the left forefinger is next placed in the wound so as to press down the rectum and feel for the staff, which is soon reached by making a few light touches with the edge of the knife, dividing the transversus perinei, and opening the triangular space between the accelerator urinæ and erector penis muscles. The finger-nail is pressed into the groove of the staff at as *low* a point as can be felt, and upon the nail the point of the knife is introduced, so as to open the membranous part of the urethra; the surgeon then drops the handle of his knife a little, so as to fix it firmly beneath the knuckle of the index finger, and turning the blade half sideways (*lateralizing* the knife) and slightly depressing its handle, pushes it steadily onwards along the groove of the staff (which it must never leave), following it constantly with the left forefinger to protect the rectum, until the cessation of resistance and the escape of urine show that the bladder had been reached; the knife is then cautiously withdrawn, still lateralized, and kept closely to the staff, so as not to enlarge the incision.[1]

FIG. 492.



Deep incision in lithotomy. (FERGUSSON.)

The surgeon now lays down his knife, and placing his left forefinger *above* the staff, insinuates it by a twisting movement into the bladder, *between the concavity of the staff and the roof of the urethra;* by observing this precaution, there is no danger of the surgeon pushing the neck of the bladder before him, and thrusting his finger into the recto-vesical space. The stone is usually felt lying at the end of the staff. If the perineum be very deep and the prostate much enlarged, the surgeon's finger may not be long enough to reach the bladder, and then the blunt gorget must be substituted, being introduced by cautiously pushing it along the groove of the staff. The finger having entered the bladder, the surgeon directs his assistant to withdraw the staff, and then, while selecting the forceps which he is going to use, dilates the incision of the prostate by pressing his finger in different directions; the forceps are next introduced closed, along and above the palmar surface of the finger, which is slightly withdrawn as the forceps enter; the forceps having touched the stone, are opened, one blade being depressed against the wall of the bladder, when the calculus will commonly fall into the grasp of the instrument; the left forefinger is now placed upon the stone, rectifying its position, if necessary, so as to make its long axis correspond to the line of the wound, and extraction is then effected, in the direction of the axis of the pelvis, with a slow, swaying, to-and-fro movement, such as obstetricians employ in applying the forceps to the fœtal head.

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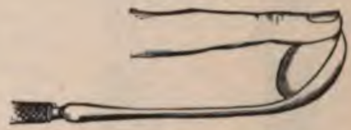
[1] Furneaux Jordan introduces a knife with a concealed blade, and, having removed the staff, incises the prostate and neck of the bladder in an *anterior* direction.

In some cases it is more convenient to lay aside the forceps, and effect extraction with the scoop employed as a *vectis;* should, unfortunately, the stone be broken in extraction, the scoop must likewise be used to remove the fragments. After the calculus has been extracted, the surgeon again introduces his finger (or the searcher, if the perineum be deep and the bladder sacculated), and makes a careful exploration to ascertain if there is another stone remaining, such being cautiously dealt with in the same manner as the first. When all calculous matter has been removed, the surgeon, as a matter of precaution, washes out the bladder through the wound with a syringeful of tepid water, and then having seen that there is no hemorrhage, has the patient untied and placed in bed.

FIG. 493.

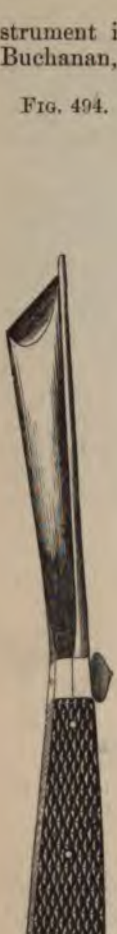


Position of finger and scoop in extracting stone. (ERICHSEN.)

After-treatment.—This is sufficiently simple. The bed must be protected with India-rubber cloth covered with a folded sheet or blanket, to absorb the urine (which of course flows through the wound), the sheet being frequently changed, so as to keep the patient dry and comfortable. For a day or two the urine escapes entirely by the wound, then probably for a few hours by the urethra (owing to the swelling of the deep part of the incision), and then again partly by the wound in gradually decreasing quantities as the healing process continues. No dressing should be applied as long as any water escapes through the perineum, but after this the incision may be treated as a superficial wound in any other situation. Opium may be administered in the form of a suppository, to relieve pain and insure sleep, the diet and general treatment of the patient being adapted to his constitutional condition.

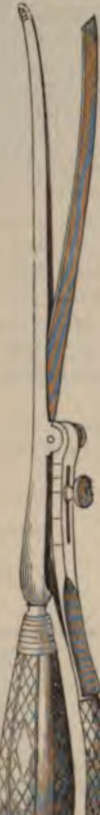
Variations.—The operation of lateral lithotomy, as above described, is varied in different ways by many surgeons; thus as regards the *staff*, many, as already mentioned, have the groove on the left side, and project the instrument into the perineum; Aston Key employed a straight staff, and Buchanan, of Glasgow, uses one which is not curved but rectangular; the latter instrument has been further modified by Hutchinson, by making the staff hollow and adding a stopcock, so that it can be used as a catheter. Still more complicated forms of apparatus have been devised by Earle, N. R. Smith, Corbett, Wood, and Avery, designed to render it impossible for the surgeon to miss the groove of the staff in making his incision. Instead of using the same *knife* for the deep as for the superficial part of the wound, some surgeons employ a probe-pointed or beaked knife after opening the urethra, while others prefer the *cutting gorget* (Fig. 494), and still others the *lithotome caché* (Fig. 495); excellent operations have been done with each of these instruments, and I have no wish to decry their usefulness in the hands of those who feel that the procedure is thereby rendered easier or safer; but for my own part I am quite satisfied with the simple bistoury, and think it an advantage not to have to change the instrument during the operation.

FIG. 494.



Physick's cutting gorget.

FIG. 495.



Frère Côme's *lithotome caché*.

In common with most surgical writers of the present day, I have advised a very *limited incision of the prostate and neck of the bladder*, the wound to be subsequently dilated with the finger—and I certainly believe this to be the best mode of practice; other surgeons, however, as Teevan, recommend a free division of the prostate, and believe that by this course they increase the probability of a successful result. I have not advised the introduction of the *lithotomy tube* in cases uncomplicated by hemorrhage, but many surgeons employ it in every instance, partly to prevent the accumulation of clots in the wound, and partly with the idea that its use diminishes the risk of urinary infiltration; I do not think it necessary in ordinary cases, but there is no particular objection to its employment, and, if the surgeon cannot see his patient at short intervals after the operation, its use may be proper as a measure of precaution.

Difficulties in the Operation.—The most difficult part of the operation, *in the case of children*, is to reach the bladder, the extraction of the stone being then usually effected without any trouble. If the rule which has been given, to pass the finger between the upper surface of the staff and the roof of the urethra, be followed, there will be little risk of missing the bladder. If, however, the finger be thrust in from below, it may readily tear across the membranous portion of the urethra, and, pushing the neck of the bladder before it, enter the recto-vesical space. If such an accident should happen, and should be noticed before the staff is withdrawn, the surgeon may retrace his steps, and, fixing the knife firmly in the groove of the instrument, notch the neck of the bladder, and cautiously introduce his finger into the organ; if the staff has been already withdrawn, it should be reintroduced, if possible, when the surgeon may proceed as before; but if this cannot be done, the operation should be abandoned and the wound allowed to heal. This course, though mortifying to the surgeon's pride, is infinitely preferable to endangering the life of the patient by attempting to reach the bladder without a guide.

In the adult, the bladder is usually reached without trouble, but there may be considerable difficulty in seizing and extracting the stone. This is commonly due either to the *position* or to the *size* of the calculus.

(1.) *Difficulty in Extraction from the Position of the Stone.*—The stone may be lodged at the inferior fundus of the bladder, *behind an enlarged prostate;* extraction is to be effected by using forceps with a decided curve, and by pushing up the bladder with the finger in the rectum. If the stone, on the other hand, is at the superior fundus, *above the pubis*, it may be brought into reach, as advised by Aston Key, by compressing the wall of the abdomen. If the stone be caught between the *folds of the vesical mucous membrane*, or between the *enlarged fasciculi* of the bladder, an attempt may be made to dislodge it by patient manipulation with the finger and scoop, or perhaps by directing upon the calculus a stream of tepid water; it is sometimes recommended to expand the walls of the bladder by opening very large forceps within it, in the hope that the stone may then drop out from its hiding-place, but the plan is not free from danger, and there is reason to believe that rupture of the bladder has been thus produced. *Spasm of the bladder*—a kind of hour-glass contraction of the organ—is said to occur sometimes, preventing the seizure of the stone; all that could be done in such a case would be to wait patiently until the spasm should disappear, postponing, if necessary, the completion of the operation until another day. If the calculus be *adherent* or *encysted*, its removal will be attended with great difficulty; if merely adherent, the stone may perhaps be coaxed away from its bed with the scoop—with all gentleness, however, lest the bladder itself be torn. If the calculus be encysted, it will probably be necessary to abandon the operation, though an attempt might in some instances be made to enlarge the orifice of the cyst (as was done by Brodie), with a probe-pointed knife, and then enucleate the stone, as it were, with the scoop. *Deformity of the pelvis from rickets* may prove an obstacle to extraction, as in cases observed by Erichsen, Thompson, and others.

(2.) *Difficulty arising from the Size of the Stone.*—If the short diameter of the calculus exceed an inch and a half in length, extraction will always be difficult, and if it exceed two inches, almost impossible without dangerous bruising of the prostate. Under these circumstances the surgeon must either (1) gain more room by incising the right side of the prostate, (2) reduce the size of the stone by crushing it within the bladder, or (3) resort to the recto-vesical, or to the supra-pubic operation. *Incision of the right side of the prostate* was the plan recommended by Liston, and is readily accomplished with the probe-pointed knife, guided by the finger. *Crushing the stone within the bladder*[1] is attended with some risk, on account of the contracted state of the organ, unless the calculus be soft, when it may be readily broken up with strong forceps. This plan was adopted by Prof. Nathan Smith, of New Haven, who, according to his son, Prof. N. R. Smith, of Baltimore,

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[1] Dr. Dyer, of Hartsville, Tenn., has recorded a most remarkable case in which a surgeon *split* a stone in the bladder by repeated blows with a *chisel and mallet;* the patient recovered! Large calculi have been broken up after lithotomy by *drilling*, by Civiale (who invented an instrument for the purpose), Miss Anna E. Broomall, of this city, and others.

"was always desirous of accomplishing that which many operators have deprecated, the fracture of the stone by the forceps." After crushing, the fragments must be carefully removed, and the bladder repeatedly washed out with a stream of tepid water. If the incision of the right side of the prostate does not give sufficient room, and the stone cannot be crushed without endangering the integrity of the bladder, the only remaining course is to perform either the *recto-vesical* or the *high operation*—the former being probably the preferable procedure.

Dangers, Complications, and Accidents of the Operation.—These may arise during or after the operation. Thus, in making the *incision*, if the knife be entered too far forwards, or penetrate too deeply at the upper part of the wound, the artery of the bulb, or the vessels of the corpus cavernosum, may be cut, giving rise to troublesome hemorrhage; if, on the other hand, the incision be placed too low, there is some risk of wounding the rectum, of cutting through the entire breadth of the prostate and neck of the bladder, thus allowing infiltration of urine behind the pelvic fascia, or even of opening the bladder entirely behind the prostate, an accident which would in all probability be fatal. Again, if the knife be too much lateralized, in making the deep incision, the pudic artery may be wounded; while, if not sufficiently lateralized, the rectum will be endangered. Finally, if the knife be not kept closely to the staff, in the deep incision, the posterior wall of the bladder may be injured, and it has, according to Miller, even happened (with the cutting gorget) "that by a more heroic thrust the bladder has been completely perforated, the intestines have protruded, and after death the liver has been found wounded."

Dangers may arise during the *extraction* of the stone from a portion of mucous membrane being caught in the grasp of the forceps, from the surgeon pulling too much upwards—not in the direction of the axis of the pelvis—and thus attempting to force the stone through the narrowest part of the pelvic outlet, or from the extraction being effected with such rapidity as to bruise and tear instead of dilating the prostate. It occasionally happens that the extraction of a stone is impeded by a portion of an enlarged prostate—a lobule, as it were, resembling an adenoid tumor—becoming entangled in the triangular space between the blades of the instrument and the calculus. The usual practice, under these circumstances, is gently to push back the protruding body, but Sir William Fergusson has given the high sanction of his name in commendation of a bolder course, no less than the enucleation of these semi-detached prostatic masses—a plan which he declares is perfectly safe, while it has the manifest advantage of enabling the surgeon to relieve the prostatic affection at the same time that he removes the stone.[1]

Among the rarer *accidents* occasionally met with after lithotomy are (1) the discovery, after a few days, that a *second* stone or calculous *fragments*, which at first escaped detection, remain in the bladder—to be remedied by dilating the wound and extracting, or by lithotrity; (2) the persistence of a *perineal fistula*—the treatment of which condition will be described hereafter; (3) *sexual impotence*, or *sterility*, usually attributed to wound of the seminal duct, but, according to Thompson, really due to sloughing or inflammatory action—probably incurable; (4) *incontinence of urine*—to be treated as when arising from other causes; and (5) *no stone being discoverable* when the forceps are introduced—a most mortifying occurrence, which may result from an error of diagnosis, no calculus having existed, from the stone being encysted or lodged in a pouch of the bladder, where it cannot be found, from its having escaped from the wound with the first gush of urine, or, finally, from the surgeon having missed the bladder and cut into the recto-vesical space. If the stone cannot be found, all that can be done is to abandon the operation for the time, and this should be done before the patient is exhausted by the repeated but fruitless introduction of instruments into the bladder. If the symptoms of calculus persist after the wound has healed, a careful examination with the sound should be again instituted, when, if the stone be unmistakably present, the operation may be repeated. It has occasionally happened that a second lithotomy has enabled the surgeon to extract a calculus which completely eluded discovery at the time of the first operation.

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[1] This practice has also been adopted by Cadge, Keith (of Aberdeen), C. Williams, and Harrison, of Liverpool.

Treatment of Complications. 1. *Hemorrhage.*—The superficial and transverse perineal arteries, one or both, are always divided in lateral lithotomy, but rarely give trouble, though, if large, they may require ligatures. The artery of the bulb or the internal pudic may be wounded, even in the hands of the most skilful operator, on account of an abnormal distribution of these vessels, and, from a similar cause, the dorsal artery of the penis or the inferior hemorrhoidal may be likewise exposed to injury. The application of ligatures to the deep arteries of the perineum is sometimes attended with great difficulty, or may even be impossible. Under such circumstances the surgeon may rely upon pressure, kept up by the fingers of assistants for several hours, or may pass a tenaculum beneath the bleeding vessel and tie the instrument in the wound, as was successfully done by Physick, in 1794, and as has since been recommended by Thompson, and by Keith, of Aberdeen, the latter surgeon having devised for the purpose a tenaculum, from which the handle can be detached at will. Another plan, also suggested by Physick, is to pass, with suitable forceps, a curved needle armed with a ligature beneath the vessel, and then, disengaging the forceps, draw out the needle and secure the vessel with a knot. When the bleeding artery is far back, at the side of the prostate or by the neck of the bladder, "I know," says John Bell, "of no way of securing it but by laying hold of it with the old artery-forceps and letting them remain for the night." The same purpose may be accomplished by using the "artery-compressor" with movable handle, devised by Prof. Gross, or by catching the vessel with an ordinary *serre-fine*, provided with a ligature hanging out of the wound, to facilitate its withdrawal.

Venous hemorrhage sometimes occurs very insidiously, the blood flowing backwards into the bladder, where it may become coagulated, instead of escaping externally. When the bleeding is from a superficial vein, this should be unhesitatingly tied; but if the hemorrhage proceed from the prostatic plexus, it will be better to introduce the lithotomy-tube, surrounded with a piece of muslin arranged as a "petticoat" or "shirt" (*canule à chemise*), into which strips of lint can be stuffed so as to firmly plug the entire wound, or, as recommended by Créquy, Guyon, and Buckstone Browne, with an India-rubber bag which can be distended with air after it is placed in position. Cold irrigations and the application of ice-bags to the perineum and hypogastrium may also be of service, or cold and pressure may be combined by using the tube and India-rubber bag, and filling the latter with iced water.

Hemorrhage, though seldom the immediate cause of death after lithotomy, is always to be dreaded, as it certainly predisposes the patient to the occurrence of diffuse inflammation of the areolar tissue around the wound.

Secondary hemorrhage is a comparatively rare complication of lithotomy.

It is to be treated by the application of ligatures, if the source of hemorrhage can be discovered, but if not, by the use of styptics and pressure, or by the actual cautery.

2. *Wound of the Rectum* is an annoying, but usually not a very serious, accident. If the wound be of small extent and low down, it will probably heal spontaneously, but, under other circumstances, may lead to the formation of a recto-vesical fistula, which must be remedied in the way described at page 847.

3. *Diffuse Inflammation of the Areolar Tissue surrounding the Neck of the Bladder and the Rectum* may arise from *infiltration of urine*, or from *bruising* of the part in the attempt to extract a large stone. Urinary infiltration, which is probably not as often met with as was formerly supposed, arises from too free division of the prostate in the deep incision. It has been suggested that the occurrence of this accident might be prevented by the use of the lithotomy-tube, but as the urine always flows out alongside of the tube as well as through it, it is evident that nothing can be gained in this way. The second condition which gives rise to diffuse areolar inflammation, bruising of the parts around the neck of the bladder, is due to rough manipulation and the endeavor to bring a large stone through an opening which is too small for the purpose. The remedy is not to hastily enlarge the incision, for this exposes to the risk of urinary infiltration, but to effect gradual dilatation by means of the finger and by the lever-like action of the forceps, notching, if necessary, the opposite side of the prostate, crushing the stone, or even resorting to the recto-vesical section (see p. 909). The occurrence of diffuse inflammation of the areolar tissue is certainly predisposed to by the existence of renal disease, and by excessive loss of blood at the time of the operation. The *treatment* consists in the administration of nutritious food, with stimulants and tonics, and in making free incisions to allow the escape of pent-up fluids. Brodie in one case saved his patient by freely dividing all the tissues between the perineal wound and the rectum.

4. *Other Complications* may arise, such as *sloughing of the wound, inflammation of the bladder or kidneys, peritonitis, erysipelas, pyæmia*, or *tetanus*, the treatment of which affections is to be conducted on the principles which guide the surgeon in their management when they occur under other circumstances.

Results of Lateral Lithotomy.—The results of lithotomy are unquestionably more influenced by the age and general condition of the patient, the size of the stone, etc., than by the greater or less degree of skill with which the operation is executed; manual dexterity is, however, by no means to be despised, and lithotomy is justly declared by Sir Henry Thompson to be a "grand operation," and "one of the best practical tests of a good surgeon."

The statistics of lithotomy have been investigated by numerous authors, and the general mortality—for all ages and conditions—appears to be about one in seven or eight. The effect of *age* in influencing the result of the operation is very marked; 377 operations on patients between 6 and 11 years old gave, according to Thompson, but 16 deaths, a mortality of but little over 4 per cent., while, on the other hand, 233 operations on patients between 59 and 70 gave 63 deaths, a mortality of over 27 per cent. In neither category were the cases in any way selected. That the *size and weight* of the stone influence the result of the operation is seen from Crosse's tables, which show that the mortality of cases in which the stone weighed less than half an ounce was 8½ per cent., and of those in which it weighed more than half an ounce, 19½ per cent. But nothing influences so decidedly the results of lithotomy as the condition of the urinary organs; "it is" says

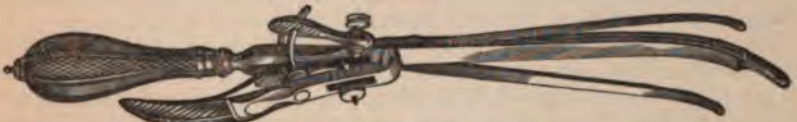
Brodie, "organic disease of the urinary organs, the kidneys, or bladder, or parts connected with them, that is to be especially apprehended, as increasing, tenfold, the hazard of the operation. Of persons in whom the calculus is not of a large size, on whom the operation is performed, I will not say very well, but not very unskilfully, and who are free from all organic disease, there are very few who do not recover; while of those in whom organic disease exists, there are few who do not die."

For the statistical results of lateral lithotomy, as compared with lithotrity, see page 900.

BILATERAL LITHOTOMY.

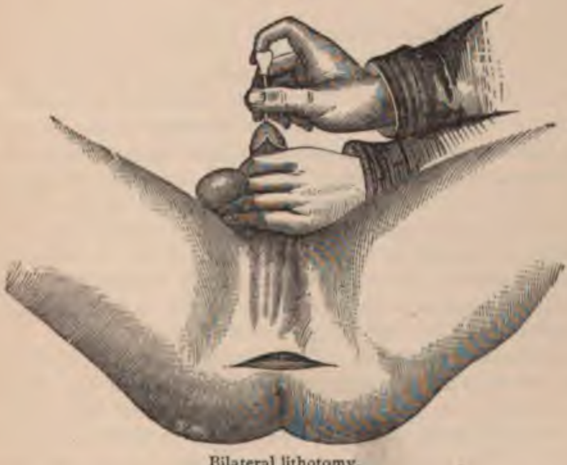
This operation was introduced in its present form by Dupuytren, in 1824, and has been, in this country, particularly illustrated by the late Prof. Eve and Prof. Briggs, of Nashville, and by Prof. Hughes, of Keokuk. The first-named surgeon is said to have performed it in 92 cases, with only 8 deaths. The instruments required are a staff, grooved in the median line, a scalpel, a *double lithotome caché* (Fig. 496), modified by Dupuytren from the single lithotome of Frère Côme (Fig. 495), which is still used by French surgeons in the lateral operation, forceps, scoops, etc. The first incision is made in a curve around the rectum, the extremity on each side reaching to a point midway between the anus and tuber ischii, or a little nearer the latter, and the middle of the incision passing from a half to three-quarters of an inch in front of the anus; the wound is then deepened until the membranous portion of the urethra is exposed, when this is opened sufficiently to admit the beak of the lithotome, which is introduced, closed, along the

FIG. 496.



Dupuytren's *lithotome caché*, opened.

FIG. 497.



Bilateral lithotomy.

groove of the staff into the bladder. The instrument having touched th stone, is turned with its concavity downwards, when the staff is withdrawn the surgeon now expands the blades of the lithotome to an extent previousl determined, and regulated by means of a screw, and divides both lobes the prostate from within outwards by drawing the instrument out with th handle well depressed and exactly in the median line of the patient's bod The finger is then passed into the bladder, and upon this the forceps a introduced, extraction being completed as in the lateral operation.

The theoretical *advantages* of this operation are, that the wound bein placed low, there is little or no risk of hemorrhage, the arteries of the bul and the transverse and superficial perineal arteries being all above the lin of incision, and that the prostate is equally divided upon both sides, thu giving a free opening into the bladder; in practice, however, the bilater is not found to be any more successful than the lateral method, which is, think, an easier operation. Gross has collected 514 cases of bilater lithotomy, with 41 fatal results, a mortality of about 1 in 12½.

Instead of pushing in the lithotome along the groove of the staff, som operators take the latter instrument in their own hands as soon as the bea of the lithotome is lodged in its groove, and, by depressing the handle wit a quick rocking motion, bring both instruments together into the bladder this manœuvre I have seen skilfully executed by the late Prof. Joseph Pan coast, of this city.

PRE-RECTAL LITHOTOMY.

This, which is a modification of the ordinary bilateral method, was intro duced by Nélaton, and consists in making a careful dissection in front o the rectum, so as to open the urethra at the apex of the prostate, without coming in contact with the bulb; the remaining steps of the operation are the same as in Dupuytren's method.

MEDIO-BILATERAL LITHOTOMY.

This operation was introduced by Civiale, in 1829, and was adopted in several instances by Sir Henry Thompson, who has, however, since abandoned it in favor of the lateral method. The staff being firmly held by an assistant, an incision about an inch and a half long is made in the median line of the perineum, terminating a little in front of the anus, and cautiously deepened so as to open the membranous portion of the urethra without wounding the bulb; a *straight* double lithotome is then lodged in the groove of the staff and pushed on into the bladder, dividing both lobes of the prostate as it is withdrawn, just as in Dupuytren's method. Sir Wm. Fergusson has imitated this plan, as regards the external wound at least, by making a perineal incision in the form of an inverted ⅄.

Civiale's seems to me on the whole better than Dupuytren's operation, but neither presents any particular advantage over the lateral method; either may, however, be properly resorted to in cases in which the stone is large, and in which hemorrhage is to be for any reason specially dreaded. Prof. Briggs, of Nashville, has successfully employed the medio-bilateral method in nine cases.

MEDIAN LITHOTOMY.

This is an old operation, formerly known as the "*Marian*" (from Marianus Sanctus Barolitanus, a surgeon of the sixteenth century), but revived with improvements by Manzoni, De Borsa, and Rizzioli, and perfected by Allarton, whose name it now generally bears. A staff grooved in the median line is firmly held against the pubis by an assistant, when the surgeon introduces his left forefinger with the palmar surface upwards into the rectum, placing its tip upon the apex of the prostate; a straight bistoury, double-edged at the point, is then entered with its principal cutting edge upwards, in the median line of the perineum, half an inch in front of the anus, and pushed steadily onwards until it penetrates the membranous portion of the urethra and lodges in the groove of the staff; the apex of the prostate is now notched by pushing the knife a few lines towards the bladder, and the urethra then slightly divided and the external wound enlarged to about an inch and a half, by cutting upwards as the knife is withdrawn. A ball-pointed probe is next passed into the bladder, along the groove of the staff, which is then removed—the surgeon's finger following the probe and dilating the prostatic incision in its course; the forceps are then introduced, and the stone extracted as in other operations. In order to assist the dilatation of the prostate, Allarton has suggested the use of fluid pressure applied by means of an Arnott's dilator, and Teale, Dolbeau, and others, have devised metallic instruments for the same purpose; as pointed out, however, by both Erichsen and Thompson, instrumental is much less safe than digital dilatation.

Allarton's operation has been variously modified by other surgeons, as by Thompson, who exposes the staff by cutting from before backwards, and by Erichsen, who employs a rectangular staff, passes a beaked director along the groove after making the incision (to open the way for the finger), and effects digital dilatation before withdrawing the staff, as in the lateral operation.

The *advantage* of the median over the lateral operation is the diminished risk of *hemorrhage* (though, according to Thompson and Cadge, the gain in this respect has been greatly exaggerated), and of *urinary infiltration.* Its *disadvantage* is the limited amount of space which it affords for the extraction of the stone. Hence its application should, it seems to me, be practically limited to those cases among *adults* in which, though the stone is small, lithotrity is inadmissible, and hemorrhage particularly to be feared. It is decidedly *contra-indicated* by the presence of a large stone, and by hypertrophy of the prostate, which interferes with the manipulation of the forceps through the small opening afforded by the median incision.

There is, however, another class of cases, in which the median operation often answers a very good purpose, and that is when it becomes necessary to cut into the bladder to remove a *foreign body* (see p. 385).

Allarton has collected 139 cases of the median operation, with 13 deaths, or a little over 9 per cent.; his tables are, however, according to Poland, not very accurate, many known cases of death after the median operation being unrecorded, and section of the prostate having been required in two of the author's own cases which are reported as successful. The statistics of the Norfolk and Norwich Hospital, as collected by Mr. Cadge, give a much less favorable picture, 90 cases, at all ages, having given 16 deaths, a mortality of nearly 18 per cent.

Dolbeau has introduced a modification of the median method, which he calls *perineal lithotrity*, and which consists in opening the membranous portion of the urethra, dilating the neck of the bladder, crushing the stone, and removing the fragments through the perineal wound, all at one operation. The principal advocate of Dolbeau's method in this country is Dr. Gouley, of New York.

MEDIO-LATERAL LITHOTOMY.

This operation, which was introduced by Buchanan, of Glasgow, in 1847 has been already referred to as a modification of the ordinary lateral method It is performed with a rectangular staff *grooved upon the left side*, which i fixed so that the angle corresponds to the apex of the prostate, and wel pressed down so as to be readily felt from the perineum. The operator keeping his left forefinger in the rectum, "enters a long straight bistoury opposite the angle of the staff, and therefore immediately in front of the anus: he holds it in his right hand, with the palm upwards; the blade horizontal and its edge directed to the left; and he pushes it straight into and along the groove as far as to the stop at its extremity. He thus enters the bladder at once, taking care to keep the blade parallel with the horizontal or grooved portion of the staff throughout the whole of the thrust. Next he withdraws the bistoury slowly, but, as he does so, cuts outwards and downwards a distance rather more than equal to another breadth of his blade [a quarter of an inch], and then directly downwards to the same extent, describing, in this manner, a curved line equal to about one-fourth of a circle round the upper and left side of the rectum." This operation makes an external wound of about an inch and a quarter in length, and has, according to Thompson (from whose pages the preceding description is taken), been performed over 60 times, with results corresponding very closely to those obtained by Allarton's method. The name *medio-lateral* is also given by H. Lee to a somewhat similar operation devised by himself.

These are the principal operations by which it is sought to remove a stone from the bladder by incision through the perineum, and from which the surgeon has to choose in ordinary cases. Each method has certain merits and demerits, and each may be properly adopted in particular circumstances. As, however, the success of lithotomy depends, to a considerable extent, upon the readiness and skill with which the operation is performed, and as to acquire equal facility in each of these methods would require a wider experience in stone cases than falls to the lot of most surgeons, I would strongly advise the general practitioner to familiarize himself with one procedure (and the ordinary lateral method I consider decidedly the easiest and safest in the large majority of instances), and, having acquired sufficient skill in its performance, to be content. It is doubtless desirable for the professed lithotomist, who counts his cases by scores or even by hundreds, to try every new plan that is suggested, and to publish his experience with it for the benefit of the whole profession; but there is no reason why the general practitioner, who, perhaps, sees but half a dozen cases in the whole of his career, should feel obliged to operate by three or four different methods. It will, on the contrary, I believe, be much better for his patients for him to be able to do one operation well, than a larger number with doubt and hesitation.

RECTO-VESICAL LITHOTOMY.

This operation, which was devised by Sanson, aims to extract the stone by an incision through the rectum. A staff is held in the ordinary manner, and into its groove the surgeon thrusts the point of his knife (guarded by the left forefinger) through the prostate, from the rectal surface, cutting then upwards and outwards through the sphincter ani and perineum. The fingernail is then placed in the groove at the membranous portion of the urethra, and the bladder opened by an incision from before backwards, joining the original wound. Extraction is effected as in other operations. Maisonneuve has modified this procedure by making an incision through the rectum *above* the sphincter, which is not divided, the section of the prostate being completed with a double lithotome. Chassaignac has performed recto-vesical lithotomy with the *écraseur*.

This operation, in addition to the risk of diffuse cellulitis and peritonitis by which it is attended, exposes the patient to the possibility of the formation of a recto-vesical fistula; to meet this contingency, Prof. Bauer, who is the most prominent advocate of the method in this country, adjusts the edges of the wound with metallic sutures, with the view of securing primary union, and a similar plan has been followed by Dr. Noyes.

König has collected 83 cases of this operation, which gave 56 cures, 11 recoveries with fistula, and 16 deaths. The operation is, in my judgment, only to be recommended in cases of very large stone, in which extraction by the lateral incision has been found impracticable (see p. 910).

SUPRA-PUBIC LITHOTOMY.

(*The High Operation.*)

This operation, which appears to have originated with Pierre Franco, in the latter part of the sixteenth century, and which was first performed in this country by the late Prof. Wm. Gibson, is designed, as its name implies, to effect the extraction of a vesical calculus through an incision above the pubis, where the bladder is not covered by peritoneum. It may be performed as follows: The parts having been shaved, and the rectum emptied by means of an enema, the patient is etherized, lying on his back with the pelvis elevated, so that the abdominal viscera may not press upon the bladder; this organ is then fully injected (but not over-distended) with tepid water,[1] and a well-curved sound or solid cathether introduced, so that by depressing its handle between the patient's thighs, the beak of the instrument may become prominent in the supra-pubic region. An incision about three inches long is now made, exactly in the median line, and reaching at its lowest point to the upper margin of the pubic symphysis: the wound is cautiously deepened until the linea alba is reached, when this is opened at the lowest part of the incision, and divided upwards with a probe-pointed knife for a distance of an inch and a half or two inches, taking great care not to wound the peritoneum, by gently pushing it out of the way of the knife. The surgeon now carefully cuts down upon the extremity of the sound, which is made to project in the wound, and thus opens the bladder—the incision into this organ, which should be held forward with tenacula, being then enlarged by cutting downwards towards its neck (and therefore below the symphysis) with a probe-pointed knife. One or two fingers are next introduced so as to ascertain the position of the stone, which is extracted with forceps in a line corresponding to the oblique direction of the wound. Langenbuch advises that the operation should be done antiseptically in two stages, which should have an interval of five or more days between them.

Civiale devised several special instruments for use in this operation, the most important being the *sonde à dard*, a catheter with a stylet which could be protruded from the concave surface of the instrument, designed to make the opening into the bladder from without inwards.

The after-treatment is very simple; the patient should be kept in bed with the limbs drawn up so as to relax the abdominal muscles, the wound being allowed to heal by granulation[1] under simple dressing. A flexible catheter may be introduced through the urethra and allowed to remain, so as to prevent urinary accumulation, but should be removed if it produce any vesical irritation.

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[1] Petersen, Gosselin, and Bois advise that the bladder should be pushed upwards by introducing an India-rubber bag (air-pessary) into the rectum, and inflating it.

Diffuse areolar inflammation may follow the operation, and is usually attributed to the occurrence of urinary infiltration: it is probable, however, that, as in the case of the lateral method, bruising of the edges of the wound in extracting a large calculus is at least equally efficient in giving rise to this complication.

The high operation has been recommended by some of its advocates as a method of universal application, but is now generally and, in my opinion, properly reserved for cases in which the calculus is of unusual size—more, for instance, than two or two and a half inches in its lesser diameter—or in which the lateral or other perineal methods are contra-indicated by the existence of pelvic deformity. The mortality after this operation is variously estimated by Belmas, Humphry, Gross, and Dulles, at from 22 to 30 per cent. Of 56 terminated American cases, collected by the last-named writer, 40 terminated successfully and 16 proved fatal, thus giving a death-rate of 2 in 7. It is to be remembered, however, that the supra-pubic, unlike the median, operation is habitually reserved for unfavorable cases.

Recurrent Calculus.

The recurrence of vesical calculus after an operation for its removal, may be due to the persistence of the causes which gave rise to the existence of the first stone, or to the imperfect removal of the stone, a fragment having been allowed to remain in the bladder. The descent of a renal calculus is comparatively seldom a cause of recurrent stone, which is more frequently due to the continued deposit of phosphatic matter in the bladder, as the result of cystitis with an ammoniacal state of the urine. Fragments may be left in the bladder after either lithotomy or lithotrity, but are more likely to form the nuclei of fresh calculous formations after the latter than after the former operation, because in this the wound affords a free means of exit, by which any portions of stone that may be chipped off are readily washed out by the flow of urine. In the early days of lithotrity, recurrence was, indeed, a frequent event, and was not unreasonably considered a grave objection to that operation; it is satisfactory, therefore, to know that with larger experience, and with the aid of the improved forms of instrument now in use, the probability of a relapse has been considerably diminished;[2] moreover, as pointed out by Brodie, patients are willing to submit to a repetition of lithotrity, when they would refuse a second cutting operation. The *treatment* of recurrent calculus consists in removing the stone by either lithotrity or lithotomy, the choice of operation being made in accordance with the principles already laid down. If it be decided to cut a patient a second time, the incision may be made in the line of the cicatrix left by the first operation.

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[1] Bruns, of Tübingen, recommends the introduction of sutures, in hope of obtaining primary union.

[2] Of 36 cases submitted to lithotrity by Civiale, in the year 1860, no less than 10 were cases of recurrent calculus, while of 204 cases operated on by Thompson, during six years ending in 1870, only 19 were cases of recurrence.

URETHRAL CALCULUS.

Urethral calculi usually consist of renal or small vesical concretions, which, being too large for spontaneous evacuation, have become impacted in the urethral canal; but calculous matter may occasionally be primarily deposited in the urethra, in cases of urinary obstruction from organic stricture, etc. The *symptoms* of urethral calculus are difficult or painful micturition, and in some instances complete retention of urine, followed, perhaps, by ulceration and urinary extravasation; the stone can usually be felt through the structures of the penis, perineum, or rectum, and can generally be touched with a sound introduced into the urethra. The *treatment* consists in effecting removal, either by gentle manipulation with the finger and thumb, pushing the stone towards the meatus, by the use of narrow forceps,[1] etc., as in the case of foreign bodies or of fragments impacted after lithotrity, or by cutting into the urethra and extracting the stone through the incision. Before resorting to the last mode of treatment, the calculus should if possible be pushed back into the perineal portion of the canal, as urethrotomy in the scrotal portion is attended with risk of urinary infiltration, and in the penile portion with danger of the formation of a fistula. The operation may be facilitated by introducing a full-sized staff as far as the position of the calculus, the incision being made directly upon the point of the instrument. In some instances it may, perhaps, be thought better to push the calculus back into the bladder, and then dispose of it by lithotrity. In all cases of urethral calculus, a careful exploration of the bladder should be made, to ascertain if vesical concretions be likewise present; if any be found, they may, if of suitable size, be crushed; or, if the urethra have already been opened in the perineum, the incision may be readily extended so as to convert the operation into a median or into a lateral lithotomy.

PROSTATIC CALCULUS.

Calculous concretions are sometimes found in the prostate gland, resulting from the deposit of phosphatic matter upon the inspissated secretion of the part; they may be conveniently referred to in this place, though not strictly belonging to the category of urinary calculi. Prostatic calculi usually consist of about eighty-five parts of phosphate of lime, with fifteen parts of animal matter, and a trace of carbonate of lime; hence they may be readily distinguished from the vesical calculi which occasionally lodge near and become imbedded in the prostate. Prostatic calculi rarely attain a large size, have a rather smooth surface—often presenting numerous facets—and are usually of a light brown or gray color; they may exist in considerable numbers, occupying the various cells and ducts of the gland, or several may become aggregated into a single mass, through the gradual disappearance by absorption of the intervening intercellular substance. The *symptoms* are a sensation of weight and distension in the perineum, often attended by a flow of mucus, and sometimes by retention of urine; the calculus can usually be detected by exploration with a sound, aided by digital examination through the rectum. The *treatment* consists in extraction by the urethra, with long and delicate forceps—this is rarely practicable—or through a perineal incision as in the operation of median lithotomy. If the concretions are small and very numerous, it may, perhaps, be better not to resort to operative interference, but to employ palliative measures only, to relieve the irritation of the part.

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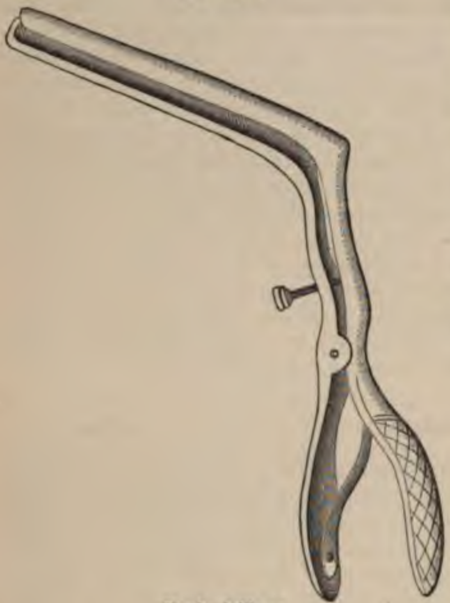
[1] Dr. Will, of Aberdeen, recommends a wire loop; the same plan was successfully employed sixty years ago in this country by Dr. Conant.

Treatment of Vesical Calculus in Women.

The operations for the removal of stones from the female bladder are lithectasy, lithotrity, and lithotomy.

Lithectasy,[1] or *Dilatation of the Urethra and Neck of the Bladder*, is much the best mode of treatment for all stones of a moderate size. The dilatation may be effected *slowly*, by the introduction of sponge tents of gradually increasing sizes; or, which is much preferable, *rapidly*, by means of a two- or three-bladed dilator,[2] or simple dressing forceps, introduced closed, and then opened so as to dilate the part upon withdrawal. The stone is extracted with ordinary lithotomy forceps or with the scoop, as may be found most convenient. The operation should be performed with the aid of anæsthesia. Bryant, who has ably investigated the literature of the subject, finds that, in children, calculi one inch in diameter, and, in adults, calculi two inches in diameter, can be safely removed by rapid urethral dilatation, without any resulting incontinence of urine.

Fig. 498.



Urethral dilator.

Lithotrity is adapted for cases in which the stone is too large to be removed by lithectasy, and yet in which the urinary organs are in a healthy condition. The operation may be performed with a short-bladed lithotrite, or with strong forceps; it is not necessary (as it is in the male) to reduce the calculus to powder, but is sufficient to break it into fragments—these being then immediately extracted with lithotomy forceps through the urethra, which is rapidly dilated for the purpose. The patient should be in a state of anæsthesia, so that the whole operation may be completed at one sitting; injections of tepid water are required to insure the removal of detritus.

Lithotomy.—This may be performed in several ways.

1. *Urethral Lithotomy* is often combined with lithectasy; the operation consists in introducing a probe-pointed bistoury into the urethra, and incising the mucous membrane with or without the submucous tissue, directly upwards as practised by Brodie, directly downwards as suggested by Chelius,

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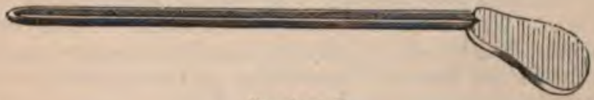
[1] This name was applied by Dr. Willis to an operation which he proposed for stone in the male, and which consisted in opening the perineal urethra and dilating the neck of the bladder; a procedure which has been supplanted by the median operation as modified by Allarton.

[2] An ingenious dilator and speculum combined has been devised by Dr. A. W. Stein, of New York.

downwards and outwards on both sides as done by Liston, or, in fact, in any direction that suits the surgeon's fancy. The operation is very apt to be followed by incontinence of urine, and appears to me in every way inferior to the method by simple rapid dilatation.

2. *Vaginal Lithotomy* has been particularly commended by Marion Sims, Aveling, Emmet, and Collins Warren, and is probably the best mode of treatment for cases in which the calculus is large, and in which crushing is inadmissible, but seems to me, under ordinary circumstances, decidedly inferior to lithectasy and lithotrity. The operation may be thus performed: A straight staff is introduced into the bladder and held by an assistant, so as to depress the vesico-vaginal septum, the point of the instrument being fixed by the surgeon's left forefinger introduced into the vagina. A sharp bistoury is then thrust through the septum into the groove of the staff, just behind the urethra, and the incision carried backwards for the space of about an inch and a half, taking care not to infringe upon the peritoneum; the stone is extracted with forceps, and the edges of the wound immediately brought together with sutures, the case being, in fact, treated as one of vesico-vaginal fistula. Simon, of Heidelberg, recommends vaginal cystotomy as a preliminary to *catheterization of the ureters* in cases of suspected impaction of a renal calculus, etc.

Fig. 499.



Female staff.

3. *The High Operation* may be required in cases in which the calculus is too large to admit of vaginal lithotomy. The operative procedure is the same as in the male sex, but requires even more care not to wound the peritoneum. Prof. Parker has, according to Gross, practised suprapubic lithotomy in the female on three occasions, and in each instance with a successful result.

4. Buchanan, of Glasgow, has practised the *lateral* operation, cutting through the left nympha upon a grooved staff introduced into the urethra. Walsham has collected four cases of this operation in children, all of which terminated favorably.

Extra-pelvic Vesical Calculus.

Calculus is occasionally developed in the protruded bladder, in cases of hernia of that organ, or *cystocele*. Prof. Gross has collected eight cases of this description. The *treatment* consists in cutting down upon the hernia (which has no peritoneal investment), and extracting the calculus—a catheter being kept in the bladder during the healing of the wound to prevent urinary infiltration. A calculus has been extracted by a Polish surgeon from a child's scrotum, whither it had made its way by ulceration of the walls of the bladder. Dr. Vosburgh has removed a calculus from the umbilical region, apparently from a patent urachus, as has Henriette, of Brussels; and other cases of urachal calculus have been recorded by T. Paget and Amussat.

CHAPTER XLV.

DISEASES OF THE BLADDER AND PROSTATE.

In no department of surgery is it more necessary for the practitioner to be a good *physician* than in that which relates to diseases of the urinary organs. So immediately connected with each other are these organs, both anatomically and physiologically, that it is impossible to treat satisfactorily even those affections which are usually considered purely surgical, as, for instance, stone in the bladder, hypertrophy of the prostate, or stricture of the urethra, without an accurate knowledge of the whole subject of urinary pathology, and more particularly a practical acquaintance with the methods of examining the urine, both chemically and by the aid of the microscope.

It is the more necessary to make this statement because the limits of this volume will only admit a description of those diseases of the urinary organs which the surgeon is habitually called upon to treat; and I must therefore refer the student, for information on the other topics mentioned, to works on the Practice of Medicine, and to treatises specially devoted to the subject of Urinary Disorders.

MALFORMATIONS AND MALPOSITIONS OF THE BLADDER.

In some cases the bladder has been totally absent, the ureters opening directly into the urethra, or into the rectum or vagina, while in other instances two or more bladders are said to have coexisted in the same subject, though, as justly remarked by Thompson, it is probable that in most of these cases the condition has not been congenital, but rather one of extreme sacculation, the result of disease. Another explanation, suggested by Demandre, who has himself observed a case of so-called "supernumerary bladder," is that the abnormal pouch may be simply a dilated urachus.

Extroversion or Exstrophy of the Bladder is by far the most common congenital defect of this viscus, and is met with sufficiently often to make its treatment a subject of considerable importance. This deformity, which is much commoner in the male than in the female sex, and which appears to be due to an arrest of development during fœtal life, consists in an absence of the anterior wall of the bladder, with a corresponding deficiency of the lower part of the abdominal parietes, and usually of the pubic symphysis. The penis in the male is epispadiac and shortened, and the clitoris, in the female, is split into two portions corresponding to the nymphæ, the anterior commissure of the vulva being wanting, and the bladder and urethra thus opening between the labia and directly into or immediately above the vagina; the uterus is commonly well formed, and in one of my cases the vaginal orifice was normally closed with a hymen. The anus is placed in front of its usual position, and, in the male, the scrotum not unfrequently contains a hernia on one or both sides. The recti abdominis muscles are separated at their lower part, passing obliquely outwards to their insertions into the pubic bones, and in many, but by no means in all, cases the separation is continued upwards almost to their costal attachments, in which case there is no umbilicus, the interval between the recti being filled with a fibrous tissue analogous to the linea alba.[1]

The *appearances* in a case of exstrophy of the bladder are quite characteristic. The posterior wall of the bladder (covered, of course, with mucous membrane) is pushed forward by the abdominal viscera which are behind it, and forms a prominent but reducible tumor in the situation of the pubes. The mucous surface, which is red, papillated, and vascular, is continuous at its periphery with the abdominal walls, the line of junction having a thin cicatricial appearance. At the lower part of the projecting vesical surface, the ureters can be seen, giving exit to the urine by drops, or sometimes in a stream. The exposed mucous membrane, which is constantly irritated by the contact of the patient's garments, becomes inflamed, and bleeds when touched, while the groins, thighs, and buttocks are excoriated from urine flowing over them.

In addition to the physical distress thus occasioned, the patient has the annoyance of knowing that he is deformed in a part which few are so philosophical as to consider of no importance in their own persons, and is besides rendered, by the continual dribbling of urine, an object of disgust to himself as well as to others. Otherwise the deformity does not particularly interfere with the general health, and is by no means incompatible with a long life; though in a remarkable case related by Dr. J. A. Masterson, of Waterloo, Wisconsin, the extroverted posterior wall of the bladder formed the sac of a hernia, which, by pressure on the ureters, led to dilatation of those organs, and ultimately to renal disease, which proved fatal. In the female the reproductive function is not impaired, and instances are on record in which women with extroverted bladders have borne children; but in the male sex the accompanying deformity of the genital organs is so great as to render procreation impossible.

Treatment.—Until within a few years, this malformation was thought to be beyond the reach of surgical aid, and the utmost that was attempted for patients thus affected, was to supply a mechanical apparatus to shield and protect the exposed bladder from injury, and to convey the urine into a suitable receptacle; but the apparatus was necessarily cumbrous and irksome, and fulfilled its design in, at best, a very unsatisfactory manner. Within a few years, endeavors have been made to remedy, or at least to alleviate, by operative interference, the condition of patients afflicted with exstrophy of the bladder, and in many instances with very gratifying success. The operations which have been devised for the purpose may be divided into two categories, viz., 1, those which aim to divert the course of the renal secretion into another channel, and, 2, those the object of which is merely to cover in the exposed bladder by a plastic operation, and thus render possible the adaptation of a convenient receptacle for the urine. To the first category belong the operations of Simon, Holmes, T. Smith, Sonnenburg, and Levis, of this city, and to the second the plastic procedures of Richard, Pancoast, Ayres, Holmes, Wood, Bigelow, and others.

1. Mr. Simon, of St. Thomas's Hospital, in the case of a boy of 13, established, by an ingenious procedure, fistulous communications between the ureters and rectum, with the hope that, the flow of urine being diverted, the exposed mucous surface of the bladder would assume the character of skin. The operation was, from the first, only partially successful, and the patient

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[1] Cheever, of Boston, has recently reported a successful operation in a case which, as described, seems to have been one of *congenital fistula* rather than of *extroversion* of the bladder. The penis and urethra were normal, and the posterior wall of the bladder protruded through an opening in the abdominal parietes, half an inch wide, and an inch above the pubis (*Bost. Med. and Surg. Journ.*, Feb. 11, 1875). A somewhat similar case has also been successfully operated on by Prof. Bigelow.

died about a year afterwards from disease of the ureters and kidneys, which apparently was set up by the irritation caused by the operation itself. In other cases in which similar procedures were undertaken, by Lloyd and Athol Johnstone, the patients died within a few days from acute peritonitis; but somewhat more successful efforts in the same direction have been recently made by Sydney Jones. Uræmic poisoning proved fatal in a case in which T. Smith turned the ureters into the colon. Dr. Levis, of this city, in two cases established a communication between the bladder and perineum, and then covered in the former organ by a plastic operation, which, however, terminated fatally in each instance. Holmes has suggested a plan of effecting the desired object, by applying in the bladder and rectum the two branches of a pair of screw-forceps (with a plate broad enough to extend from one ureter to the other), which, acting like Dupuytren's enterotome, should establish the necessary communication between the organs without risk of perforating the peritoneal cavity. Sonnenburg attached the ureters to the dorsal groove of the penis, and then dissected away the bladder—an operation of which I confess that I do not see the advantage, as it would necessarily permit the urine still to dribble constantly as before.

2. *Plastic Operations*, varying more or less in their details, have been employed for the relief of extroverted bladder, and in many instances with very gratifying results.

(1.) Richard, modifying Nélaton's operation for epispadias, operated, in 1853, by dissecting a broad flap from below the umbilicus, turning it with its skin surface towards the bladder, and covering it in with a bridge of skin taken from the front of the scrotum. This operation, though most ingeniously planned, unfortunately induced peritonitis, which proved fatal. Le Fort has recently modified Richard's operation by taking the covering flap from the enlarged prepuce instead of from the scrotum.

(2.) To Prof. Joseph Pancoast, of this city, belongs the honor of having, in 1858, performed the first successful plastic operation for exstrophy of the bladder. His method consisted in taking flaps from the groins, inverting them over the protruded organ, and attaching them together in the median line, thus leaving a broad granulating surface which slowly cicatrized. The patient recovered from the operation, but died some months later from another affection.

(3.) In the same year Dr. Ayres, of Brooklyn, N. Y., operated on a woman (who had previously given birth to a child) by turning down an umbilical flap—as had been done by Richard—covering it in by simply dissecting up the skin of the abdominal walls on either side, and bringing together the tissues thus loosened in the median line. The operation was perfectly successful.

(4.) Mr. Holmes, who has operated in a number of cases, employs two flaps, one from the groin, which is inverted, with its cutaneous surface towards the bladder, and the other taken from the opposite side of the scrotum and slid over to cover in the first. This plan was also followed by J. Wood, in some of his earlier cases.

(5.) The late Dr. Maury, of this city, in three cases adopted Roux's method, taking a saddle-shaped flap, attached at both ends, from the scrotum, and inverting it bridge-like over the bladder—leaving the raw surface of the flap to heal by granulation and cicatrization. In one case the operation failed, but in the other two furnished a good result, and in each of these Dr. Maury succeeded (as did Pancoast) in effecting the cure of a hernia by the contraction which accompanied the healing process.

(6.) Thiersch, of Leipsic, and Sir W. MacCormac employ lateral flaps which are allowed to remain attached at both ends for several weeks, until they become thick and vascular, and are then laid across the bladder, with their granulating surfaces towards the mucous membrane.

(7.) Mr. Barker, of Melbourne, has successfully operated in a young girl, by simply dissecting up the integument on either side of the bladder, uniting the flaps thus formed with deep and superficial sutures, and relieving tension by means of lateral incisions.

(8.) Prof. H. J. Bigelow, of Boston, instead of endeavoring to restore the cavity of the bladder, simply dissects off the mucous membrane as low as the level of the ureters, and covers the raw surface with flaps taken from the groins. A similar operation has also been practised by Foulis, of Glasgow.

FIG. 500.

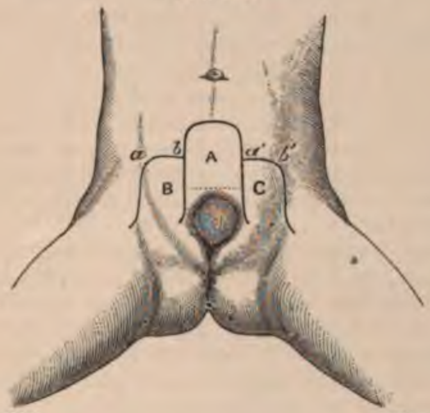


FIG. 501.

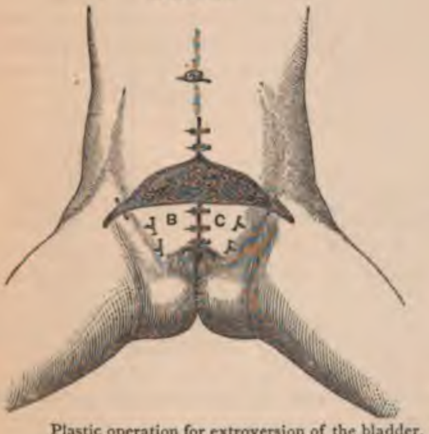
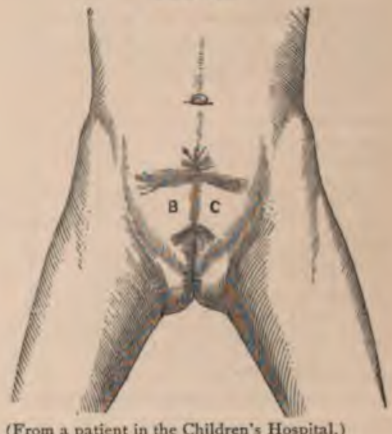


FIG. 502.



Plastic operation for extroversion of the bladder. (From a patient in the Children's Hospital.)

(9.) Prof. Wood, of King's College, London, has operated in a large number of cases, and has latterly employed a method which is now usually known by his name, and to which I have resorted in three cases, from one of which the annexed illustrations are taken. Three flaps are used, one taken from the umbilical region and inverted over the bladder, as in Richard's and Ayres's methods, and the others, one from each groin, united in the median line over the first, which they cover in. The great advantage of the inverted umbilical flap is that it effectually prevents the escape of urine in an upward direction, while the groin flaps cover in the raw surface of the other without undue tension, and, having broad bases, are in no danger of sloughing. In the case of a male subject, a roof may be formed for the urethra, at a subsequent operation, by inverting flaps from the newly-formed covering of the bladder, and from the sides of the penis, adjusting over them a bridge-like flap from the scrotum, as in Nélaton's and Richard's procedures. In two of the three cases in which I have operated, the result was quite satisfactory, but in the third, though a first operation was successful, a second terminated fatally, from shock, in a little over twelve hours.

Cases of Plastic Operation for Extroversion of the Bladder.

Operator.	Cases.	Recoveries.	Failures.	Deaths.
Agnew, ...	2	2	. .	. .
Annandale, ...	1	1	. .	. .
Ashhurst, ...	3	2	. .	1
Ayres, ...	1	1	. .	. .
Barker, ...	1	1	. .	. .
Bigelow, ...	2	2	. .	. .
Billroth, ...	2	2	. .	. .
Brigham, ...	1	1	. .	. .
Durham, ...	1	. .	. .	1
Forbes, ...	1	1	. .	. .
Hodges, ...	1	1	. .	. .
Holmes, ...	6	3	2	1
Johnston, ...	1	1	. .	. .
Jones, ...	1	1	. .	. .
King, ...	1	1	. .	. .
LeFort, ...	1	1	. .	. .
Levis, ...	2	. .	. .	2
MacCormac, ...	1	1	. .	. .
Maisonneuve, ...	1	1	. .	. .
Marsh, ...	1	. .	. .	1
Maury, ...	4	3	. .	1
Mears, ...	1	. .	. .	1
Michel, ...	1	1	. .	. .
Pancoast, ...	1	. .	. .	1
Parker,[1]	1	. .	. .	1
Richard, ...	1	. .	. .	1
Ruggi, ...	2	2	. .	. .
Sloan, ...	1	1	. .	. .
Smith, ...	2	2	. .	. .
Thiersch, ...	6	6	. .	. .
Wilkins, ...	1	1	. .	. .
Wood,[1]	16	13	2	1
———, ...	3	3	. .	. .
Aggregate, ...	71	55	4	12

By this operation the patient is placed in a very comfortable condition; incontinence of urine, to a certain extent, necessarily continues, requiring the patient usually to wear a "railway urinal," or some similar contrivance, but the bladder is effectually protected from irritation, and excoriation is readily prevented. The principal points requiring attention in the after-treatment, are to prevent tension on the flaps and encourage the contraction of the granulating surfaces by the position of the patient, who should be placed in an almost sitting posture, with the knees flexed over pillows. In an adult, trouble may be caused by the growth of the pudendal hairs, if the reversed flaps embrace any portion of skin naturally thus covered, and it will then be necessary, from time to time, to practise avulsion with suitable forceps, until the inverted surface shall have lost its cutaneous character and become assimilated in nature to mucous membrane. Injections of dilute acetic or nitric acid may also be required, to relieve vesical catarrh and prevent the deposit of phosphates. The *statistics* of these plastic operations are quite as favorable as could be expected, 71 terminated cases to which I have references, having given 55 recoveries, 4 failures, and but 12 deaths.

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[1] Mr. Parker and Mr. Wood have operated on other cases, the results of which I do not know.

Malpositions.—Under this head may be included two affections, one of which, *Hernia of the bladder*, or *Cystocele*, has already been referred to, the other being *Inversion of the bladder*, which is extremely rare, and which is almost exclusively met with in female children.

Inversion of the bladder consists in a protrusion or invagination of the bladder through the urethra, where it appears in the form of a red vascular tumor; this, in one of the few cases of the affection on record,[1] was mistaken for a new growth, and preparations had been actually made to remove it by ligation, when the discovery of the orifice of a ureter fortunately prevented the consummation of the operation. The protruding organ is readily reduced by manual pressure, but is apt to re-descend when the pressure is removed, when incontinence of urine necessarily remains. To remedy this, Dr. John Lowe, of Lynn, made repeated applications of the actual cautery to the urethra, keeping the bladder in place by means of a catheter with a bulbous extremity; he thus induced sufficient contraction to prevent any protrusion whatever, and to diminish, though not entirely to remove, the incontinence. The same object might, in some cases, be accomplished by means of a plastic operation. The administration of nux vomica was of service in a case recorded by Dr. Vance, while Dr. Langworthy derived advantage from the use of gallic acid applied as a suppository to the urethra. Recumbency alone effected a cure in a case under the care of W. L. Richardson.

CYSTITIS.

Cystitis, or *Inflammation of the Bladder*, may be *acute* or *chronic*, and in the latter case may or may not be accompanied with *vesical catarrh*.

Acute Cystitis.—The seat of inflammation is the mucous lining of the bladder, especially the part around the neck of the organ. In some cases, however, the submucous and muscular coats are also involved, and the inflammation may even spread to the adjacent layer of peritoneum. The vesical mucous membrane is found after death to be injected or deeply congested, and sometimes, if the inflammation have been long continued, of a slate-colored or chocolate hue. Occasionally, shreds or patches of lymph are formed, and in rare instances a complete cast of the interior of the organ has been thus produced. Ulceration and gangrene may be met with in the worst cases.

Causes.—Acute cystitis may result from various forms of injury, from the irritation produced by a calculus or foreign body, from the action of certain medicines, such as cantharides or some of the mineral poisons, from the use of irritating injections, from acidity of the urinary secretion, from the extension of inflammation from neighboring parts (especially from the urethra, as in cases of gonorrhœa), from an exacerbation of chronic cystitis, from exposure to cold, from gout, etc.

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[1] Mr. Croft, in 1871, could find but three cases on record besides that observed by himelf; the reporters of these were respectively Dr. Murphy, Mr. Crosse, and Dr. Lowe.

Symptoms.—There is pain over and behind the pubes, and in the sacral region, perineum, and thighs, attended in bad cases with tenderness on pressure, and increased by rectal exploration and by the use of the catheter. The desire to urinate is almost constant and irresistible, the act of micturition itself being intensely painful and often accompanied with great tenesmus. In mild cases, such as ordinarily follow gonorrhœa, and in which the inflammation is usually limited to the neck of the bladder, the urine is cloudy and contains a certain quantity of mucus and pus, but in severe cases it is tinged with blood, and soon becomes decidedly purulent, containing also shreds of partially organized lymph or false membrane. In these cases there is also a great deal of constitutional disturbance (which is almost absent in the milder forms of the affection), the patient soon falling into a typhoid condition, often attended with delirium; death may ensue, usually in the course of the second week. In the milder cases resolution occurs—when recovery may be complete—though, in many instances, the inflammation subsides into a chronic state.

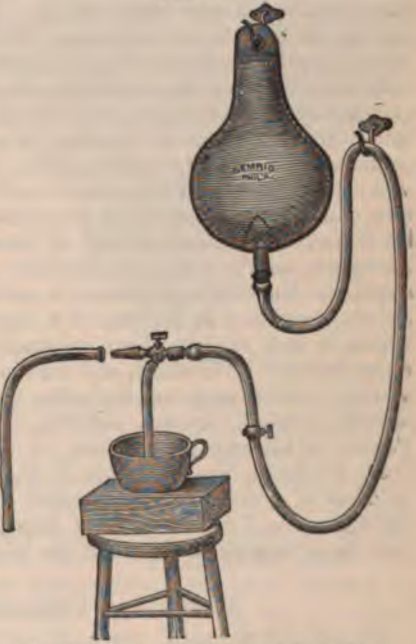
Treatment.—The patient must be kept in bed. A few leeches may be applied to the hypogastrium or perineum, and followed by hot poultices or fomentations. The bowels must be kept in a soluble condition, and pain and vesical irritation relieved by the use of hyoscyamus and opium, given by the mouth, or in the form of suppository. Enemata of atropia are recommended by Dr. Semple, of Virginia. Hot hip-baths may be administered during the acute stage, and the patient should drink moderately of flaxseed tea, or other demulcent, medicated with a small quantity of citrate of potassium. When the inflammation begins to subside, buchu or copaiba may be cautiously administered. The diet should in ordinary cases be mild and unirritating; but if typhoid symptoms appear, free stimulation must be resorted to. If retention of urine occur, catheterization with a flexible instrument must be cautiously practised, and if symptoms of nephritis be manifested, wet or dry cups should be applied over the kidneys, and followed by mustard poultices or turpentine stupes.

Chronic Cystitis may result from the same causes as those which produce the acute form of the affection (which indeed it often succeeds), from atony or paralysis of the bladder, or from any obstruction to the free evacuation of its contents—both of these conditions causing accumulation and partial decomposition of the urine, which then becomes very irritating to the vesical mucous membrane—or from tumors or other structural diseases of the bladder itself or of neighboring organs, as the rectum, uterus, or vagina.

1. Simple Chronic Cystitis, the form of the affection which is unattended with vesical catarrh, is the pathological condition which is present in most of the cases commonly called "irritability of the bladder"—a term which is not very well chosen, as it refers to a mere symptom. Microscopic examination of the urine, in cases of simple chronic cystitis, will always detect the presence of pus, and this, with increased frequency of micturition, and slight augmentation of the amount of vesical mucus, are the evidences by which the surgeon may recognize the existence of the disease. The *treatment* is the same as for the mildest cases of acute cystitis, the inflammation in many instances subsiding under the influence of rest alone.

2. Chronic Cystitis with Vesical Catarrh is characterized by the deposition from the urine of a ropy, tenacious, muco-purulent substance, usually of a grayish-white color, and of alkaline reaction. This is often mixed with phosphates, the urine itself being ammoniacal and extremely offensive. The bladder becomes thickened, roughened, and sometimes sacculated; ulceration sometimes occurs; and the case may terminate fatally by the patient falling into a typhoid or uræmic condition, to which Roser gives the name of *ammonæmia.* This form of cystitis is particularly apt to supervene in cases of vesical paralysis from injury of the spine (see p. 333). In the *treatment* of this condition, topical remedies are of the highest importance; urinary accumulation should be prevented by the cautious use of the catheter, or, as suggested by McGuire, of Virginia, by the employment of a delicate flexible tube, which may be left *in situ;* and great benefit may often be derived from washing out the bladder, by injecting at first warm water merely, and subsequently, if this be well borne, mild astringent or sedative lotions; the best, according to Thompson, are those containing acetate of lead (gr. ss to f℥iv), nitrate of silver (gr. ss to f℥iv),[1] dilute nitric acid (♏x to f℥iv), carbolic acid (♏ij to f℥iv), or borax (Sodæ boratis gr. viij-xxx, glycerinæ fʒij, aquæ f℥iv). In order to prevent ammoniacal decomposition of the urine, Dubreuil recommends injections of a weak solution of silicate of sodium (gr. iij-iv to f℥j); Clemens, of Frankfort, and Purdon, of Belfast, frequent injections of *healthy urine;* and Erichsen and Nunn, injections of quinia (gr. j-fʒj). Salicylic acid and permanganate of potassium are favorably spoken of by Schüller. Vesical injections are most conveniently made by means of an India-rubber bottle with a nozzle, and an ordinary elastic catheter; not more than three or four fluidounces should be used on each occasion, the injected liquid being kept in the bladder for a few minutes, and then allowed to flow off. When the patient himself applies the injection, Keyes recommends an ordinary fountain syringe provided with a two-way stopcock, the injected liquid thus entering the bladder by simple hydrostatic pressure (Fig. 503). A somewhat similar arrangement is employed by Zeissl, McGuire (of Richmond, Va.), and Bertholle, who dispense with the catheter altogether, simply introducing the pipe of the instrument into the mouth of the urethra. Harrision, of Liverpool, has devised an ingenious instrument for introducing *medicated pessaries* into the bladder.

FIG. 503.



Keyes's apparatus for washing out the bladder.

Counter-irritation to the supra-pubic region is often of service, and pain may be relieved by the use of anodyne suppositories. A belladonna plaster over the pubes may be used for the same purpose. Hot hip-baths will often be found useful.

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[1] T. G. Richardson employs a much stronger solution, viz., gr. xx–xxx to f℥j.

A large number of internal remedies have been employed in this affection, and, it must be confessed, often in rather an empirical manner, those which seem to succeed best in some cases, failing utterly in others. Those which are probably most deserving of mention are buchu, uva ursi, pareira, matico, chimaphila, triticum repens, senega, copaiba, and cubebs. Dr. Garnett recommends a decoction of the broom-corn seed or Sorghum vulgare. Alkalies, especially the liquor potassæ, in combination with the tincture of hyoscyamus, may be tried if there be much vesical irritation, but must be watched, lest they increase the tendency to phosphatic deposit. Chlorate of potassium is recommended by Edlefsen, and has proved quite satisfactory in several cases in which I have employed it. The mineral acids may be useful on account of their tonic properties. When the urine is ammoniacal, benzoic acid is highly recommended by Gosselin. Skene employs a combination of benzoic acid, biborate of sodium, and infusion of buchu. An exclusive milk diet is advised by Dr. George Johnson, of London, and Dr. Weir Mitchell, of this city. It is scarcely necessary to add that if the condition of the bladder depend upon any removable cause, such as vesical calculus or urethral stricture, this must be attended to before the cystitis can be cured. In the case of a female, *dilatation of the urethra* may be employed as recommended by Papin, of St. Louis, Howe, of New York, Teale, Duncan, Heath, and Hewetson, and in either sex, recourse may be had, as a last resort,[1] to *cystotomy*, the bladder in the case of a male being opened from the perineum, as in lithotomy, and in the case of a female from the vagina; the operation, which is said to have been originally suggested by Blizard, was strongly recommended by Guthrie, and has been advantageously employed in the male by several surgeons, including Syme, Fergusson, Willard Parker, Bickersteth, Parona, Bryant, Holmes, Teevan, Post, Hamilton, of Liverpool, Powell, of Chicago, and Battey, of Georgia, and in the female by Emmet, Sims, Bozeman, Simon, Hegar, C. C. Lee, and others. Weir has collected 47 cases of cystotomy for cystitis in the male; 23 patients were cured by the operation, 7 relieved, 4 not benefited, while 13 died—10 of these, however, from advanced disease of the kidneys.

STRUCTURAL DISEASES OF THE BLADDER.

Sacculated Bladder.—Obstruction to the flow of urine, as from enlarged prostate or stricture, leads to hypertrophy of the muscular walls of the bladder, and gives its inner surface a roughened and fasciculated appearance. As a result of the violent contractions of the organ in the effort to expel its contents, the vesical mucous membrane and submucous tissue protrude between the interlacing bundles of muscular fibre, and form sacs or pouches, sometimes of very large size, in which the urine accumulates and undergoes decomposition, giving rise to cystitis, and often leading to the formation of phosphatic calculi. The *treatment* should be directed to preventing accumulation, which may most conveniently be done by the use of an elastic catheter, aided by the siphon arrangement of Prof. Dittel (see p. 898).

Tumors of the Bladder.—Various forms of morbid growth are met with in the bladder—as the *fibrous*, *fibro-cellular*, and *fibro-muscular*, constituting the polypoid tumors met with in this organ, the *papillary* or *villous*, closely resembling in structure the chorion, very vascular, and sometimes, though by no means always, of a cancerous nature (see pages 489 and 502), the *encephaloid*, the *scirrhous* (usually secondary to scirrhus of the rectum), and the *epitheliomatous*. *Dermoid cysts* have also been found to communicate with, if not to originate in, the vesical cavity. Any of these tumors may become incrusted with phosphatic matter, and thus simulate calculus; but the diagnosis can usually be made by careful sounding. Hemorrhage attends both the villous and the malignant growths—in cases of the former kind being of the character of capillary oozing, and in those of the latter occurring less constantly, but in considerable quantities at a time. The *treatment*, in the large majority of instances, must be merely palliative, consisting chiefly in the free administration of anodynes, with stimulants, if necessary. Astringent injections may be tried in the cases of villous tumor, but should not be repeated if they produce vesical irritation. Polypoid, and even sessile, growths may be removed from the female bladder by the ligature, *écraseur*, or scoop, the urethra being dilated for the purpose; or, as has been done by Norton, through a vaginal incision. W. F. Atlee has successfully removed a fungous growth by dilating the urethra and scraping away the neoplasm with his nail. It may occasionally be possible to remove a vesical polypus in the male by avulsion with a lithotrite, as was done in one instance by Civiale. Humphry has successfully removed a fibroma by lateral cystotomy, and Billroth a fibro-muscular tumor (*myoma*) by incision above the pubis as in the high operation for stone, but a similar operation, performed by Volkmann on a man aged 54, ended fatally on the fourth day. Kocher and Davies-Colley have successfully removed *villous* tumors from the bladder by opening the organ from the perineum and scraping away the morbid growth with a sharp scoop, and a successful operation for villous tumor, by the supra-pubic method, has recently been recorded by Marcacci. Sir H. Thompson has succeeded in removing a vesical tumor through a perineal opening into the urethra, followed by dilatation of the neck of the bladder. Stein has collected 34 cases of operation for vesical tumor (principally in women), with 19 recoveries and 13 deaths.

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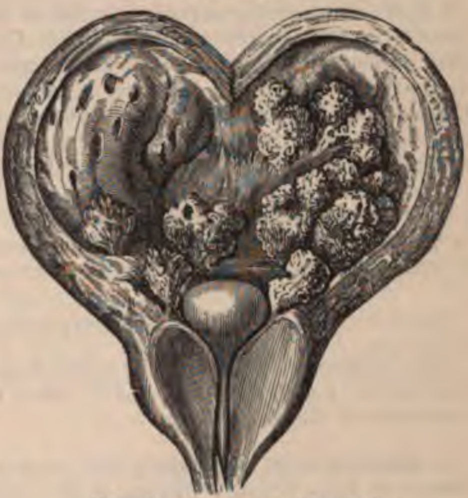
[1] Prof. Agnew suggests that the ureters might be separated from the bladder, and made to empty on the surface, in the groin or loin.

FIG. 504.



Polypoid vesical tumors. (CIVIALE.)

Tubercle of the Bladder is a rare affection, and is probably never met with except in connection with tuberculosis of other organs. The *symptoms*, as pointed out by T. Smith, closely resemble those of calculus, while the *treatment*, as far as the bladder is concerned, must be merely palliative; Smith particularly recommends the confection of black pepper (Ward's paste), to relieve the hæmaturia which often accompanies the affection.

Bar at the Neck of the Bladder.—This name was given by Guthrie to a rare form of obstruction situated at the neck of the bladder, and entirely distinct from the common hypertrophy of the middle lobe of the prostate. There are two forms of *bar*—one consisting in a ridge-like elevation of the mucous and submucous tissues, due to enlargement of the *lateral* lobes of the prostate, the median lobe being unaffected—and the other a similar fold or ridge, which Guthrie attributed to disease of an "elastic structure" (which he described as existing at the neck of the bladder), and which occurs without there being any apparent cause for its formation. The *treatment* in most cases must be palliative merely, though, if the condition could be accurately diagnosticated during life, it might perhaps be occasionally proper to divide the bar with a catheter carrying a concealed blade, as recommended by Guthrie and Mercier, the latter of whom has also devised an instrument for *excising* a portion of the offending bar; Mercier's operation has been successfully employed in this country by Dr. Gouley, of New York.

Fissure of the Neck of the Bladder is a condition described by Spiegelberg and Reginald Harrison as analogous to fissure of the anus. The *treatment* consists in dilatation and cauterization with nitrate of silver.

HÆMATURIA.

The existence of blood in the urine may be a symptom of various affections of the urinary organs,[1] and it often becomes important to determine the source of the hemorrhage.

1. **Bleeding from the Kidney** may be due to blows on the loin, to the existence of acute Bright's disease, to the irritation produced by a renal calculus, to tuberculous deposit, etc. The blood is usually intimately mixed with the urine, but may form a clot, in which case, by floating out the coagulum in water (as suggested by Hilton), its shape may betray its origin.

2. **Vesical Hæmaturia** may result from congestion of the bladder, from tuberculous disease, from the irritation caused by a calculus, or from the presence of a villous or malignant growth. The blood often coagulates within the bladder, but, when passed in a liquid form, the urine which first flows is less tinged than that which follows. If the hemorrhage be caused by a morbid growth, the appearance in the urine of shreds of the abnormal tissue, recognizable with the microscope, may aid the diagnosis.

3. **Bleeding from the Prostate** may depend upon congestion, inflammation, or tuberculous or malignant disease of that organ. The diagnosis from vesical hemorrhage may be aided by exploration with the finger in the rectum.

4. **Hemorrhage from the Urethra** may depend upon congestion or inflammation of the part; upon laceration from blows on the perineum, injuries inflicted by instruments, impacted calculi, etc.; upon rupture from straining in the effort to urinate, or from violent coitus;[2] upon ulceration from malignant disease, etc. The diagnosis of urethral hemorrhage may always be made by observing that, in urinating, blood precedes the flow of urine, and that this, if drawn off by the catheter, is clear.

Treatment of Hæmaturia.—This must vary with the source of the hemorrhage. If due to renal injury, calculus, etc., the patient must be kept in bed, and astringents, such as gallic acid or acetate of lead, with opium, administered. The confection of black pepper is highly spoken of by T. Smith. When of vesical or prostatic origin, cold applications are of service. It is better, as a rule, not to interfere with clots in the bladder, but to leave their disintegration to the efforts of nature. If, however, it becomes necessary to adopt artificial means of evacuation, a portion of the clot may be gently drawn out through a large-eyed catheter, by means of Clover's lithotrity apparatus or an ordinary stomach-pump. Dr. J. H. Ledlie, of Illinois, recommends injections of lime-water to dissolve the coagulum. For persistent vesical hæmaturia, Thompson recommends injections of nitrate of silver (gr. j–iv to f℥iv), or of the tincture of the perchloride of iron (fʒj to f℥iv). Hemorrhage from the urethra may be controlled by cold applications, or, if these fail, by introducing a full-sized catheter, and compressing the penis upon it with strips of adhesive plaster or a bandage. Bates, of Brooklyn, has devised an ingenious apparatus for applying cold and pressure *within* the urethra.

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[1] Hæmaturia, without disease of the urinary organs, has been observed by Raymond in connection with the urethralgic crises of locomotor ataxia.

[2] The bleeding which occasionally follows immoderate sexual intercourse *without rupture* is, according to Hilton, usually prostatic.

Intermittent or Paroxysmal Hæmaturia, or (as it should perhaps rather be called) *Hæmatinuria,* has been observed in several cases, by Greenhow, Harley, Fuller, Gull, and other writers, the paroxysm usually following exposure to cold. The *treatment* consists in the administration of tonics, particularly iron and quinia.

PARALYSIS AND ATONY OF THE BLADDER; RETENTION AND INCONTINENCE OF URINE, ETC.

True Paralysis of the Bladder is not very often met with; it is most commonly seen in cases of injury or organic disease of the brain or spinal cord, though it occasionally occurs as a result of functional exhaustion of the spinal system from sexual excesses, as a reflex phenomenon dependent upon injuries or diseases of other parts of the body, or as a temporary consequence of the use of belladonna or similar drugs. When the paralysis affects the neck of the bladder only, the urine constantly flows away, giving rise to *incontinence;* when the body of the organ alone is involved, the bladder cannot expel its contents, and the result is *retention;* while, if the whole organ be affected, though most of the urine may escape, the bladder remains partially distended—and incontinence and retention may thus coexist. The *treatment* consists in keeping the bladder empty (when this is necessary) by the cautious and gentle use of a flexible catheter, and in relieving by suitable remedies any cystitis that may occur. In some cases, galvanism and the administration of various tonics, especially strychnia, may be of service. The latter remedy has been successfully used by injection, in doses of $\frac{1}{16}$ gr., by Dr. W. E. Tarbell of China.

Atony of the Bladder, from over-distension of this organ, is, on the other hand, frequently met with. This condition may arise in the course of low fevers, if the catheter be not used—or even from voluntarily neglecting the calls of nature—but is most commonly due to some source of obstruction, either prostatic or urethral, which, while not giving rise to absolute retention, yet renders the bladder unable to expel its whole contents. A certain quantity of "residual urine" thus remains, and gradually increases in amount until the organ is completely distended, when the neck of the bladder becomes partially dilated, and, as pointed out by Thompson, an overflow takes place, masking the real condition, and leading the patient—and sometimes his medical adviser—to consider the case one of *incontinence* rather than *retention* of urine.[1]

Retention of Urine, though merely a symptom, is one of such importance as to demand special consideration. When it occurs gradually (as is the case when it arises from paralysis or atony of the bladder), the vesical cavity becomes slowly distended, until it may contain several quarts of urine, and forms a prominent tumor in the hypogastrium, reaching nearly to the umbilicus. The patient is usually not conscious of passing a smaller quantity of urine than in the normal condition, though a certain amount of difficulty may be experienced in completing the act of micturition—the water being expelled with less force than in health, and dribbling of urine continuing after the bladder has been apparently emptied, or occurring during sleep or upon making any muscular exertion; when the bladder has become fully distended, overflow occurs in the way already described, and simulates incontinence. The *diagnosis* of retention is usually made with facility; even if there be no hypogastric tumor, there will be dulness on percussion over the pubes, and the distended bladder can be felt by placing a finger in the rectum, when, by tapping over the supra-pubic region, fluctuation can be distinctly recognized. If, however, the walls of the bladder be thickened and contracted, the diagnosis may be more difficult. Retention of urine, if unrelieved, leads to cystitis, with an ammoniacal state of the contents of the bladder; it may even prove fatal through the supervention of a typhoid or uræmic condition.

Treatment.—The treatment of *retention with overflow,* which is the condition met with in cases of atony of the bladder, requires in the first place the systematic use of the catheter, two or three times a day, so as to evacuate the "residual urine." A long and large flexible catheter is the best, but, whatever form of instrument may be used, care must be taken that it actually enters the bladder, and not merely the prostatic portion of the urethra, which in these cases is often dilated, and may contain a couple of ounces of urine. When the retention has lasted for a long period, it may be better not to evacuate the entire contents of the bladder at once—which would probably give rise to cystitis—but to draw off a portion at a time, and thus enable the organ gradually to return to its normal state. In cases of short duration the bladder may perfectly regain its tone, but in many instances all that can be done is to palliate the patient's condition. Thompson recommends the application of the cold douche to the lumbar spine and abdomen, and the injection of cold water into the bladder. The hypodermic injection of ergotine has been successfully resorted to by Langenbeck, Iversen, and other surgeons.

Spasmodic Retention of Urine, or, as Sir James Paget has happily called it, *stammering with the urinary organs,* is a condition occasionally met with, and one which is more annoying than dangerous. A person who is liable to this form of retention should learn to use a catheter, and should constantly carry one with him, as the fear of being unable to urinate is often of itself sufficient to bring on an attack.

Hysterical Retention of Urine is occasionally observed in women, in connection with various other phenomena which are conventionally denominated hysterical. The *treatment* consists in regulating the state of the bowels, and administering tonics and nerve stimulants, with the local use of the cold douche; the catheter may be used *once*, to make sure that there is no actual obstruction, but should afterwards be withheld; rupture of the bladder never occurs in these cases, and the patient usually passes her water without difficulty, as soon as the distension becomes painful, and she is convinced that instrumental relief will not be afforded.

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[1] I recently saw a patient who, supposed to have paralysis of the bladder, had been taking strychnia for *one year*; the introduction of a catheter effected the evacuation of nearly a quart of urine, and showed the real condition to be one of prostatic retention with overflow.

Incontinence of Urine.—This may occur either in children or in adults.

1. *Nocturnal Incontinence in Children.*—The patient may wet his bed during sleep only occasionally, or may do so once or oftener every night. This infirmity may result from habit (through neglect of the nurse to take the child up at proper intervals), from excessive secretion of urine or some irritating quality of this fluid, from irritation transmitted from neighboring organs, as the rectum, or from the existence of slight chronic cystitis, of phimosis, of preputial adhesions, etc. The *treatment* consists (1) in removing the cause, if this can be ascertained; (2) in improving the general health; (3) in obtunding the excessive sensibility of the bladder; (4) in endeavoring to induce a habit of attending to the calls of nature at suitable intervals; and (5) above all, in developing a hearty wish for relief on the part of the patient, for without his co-operation, as justly observed by Brodie, little can be accomplished. The first indication is to be met by regulating the diet, attending to the digestive functions, forbidding excessive use of liquids, etc.; the second, by the administration of tonics, and the employment of sea-bathing or the cold douche; and the third, by the use of belladonna given by the mouth, in the form of tincture or extract, or by the hypodermic administration of atropia, aided in obstinate cases by the application of a solution of nitrate of silver to the prostatic urethra. The patient should be aroused and made to urinate once or twice during the night, and should be induced to strive himself to get relief from his infirmity—not by threatening punishment, but by encouraging the formation of cleanly habits.

Various remedies beside those mentioned above have been employed with more or less success, such as blisters to the sacrum, the use of an apparatus to prevent the patient lying on his back (the urine, when this position is assumed, resting on the *trigone* of the bladder, which is its most sensitive part), the application of collodion to the meatus, as recommended by Corrigan, circumcision, the application of electricity, the administration of hydrate of chloral, hypodermic injections of strychnia, etc. These may be, each or all, properly tried in obstinate cases.

2. *True Incontinence of Urine in the Male Adult* is very rare, the real condition in most cases so described being, as already mentioned, *retention with overflow.* In *women*, owing to the shortness of the urethra, incontinence of urine is more common, resulting usually from injury received during parturition. True incontinence in the male may, however, result from paralysis of the neck of the bladder—in which case the treatment appropriate to that condition must be adopted—or from a peculiar form of hypertrophy of the prostate, in which the enlarged third lobe projects wedge-like between the lateral lobes, keeping the neck of the bladder constantly patulous. Under these circumstances little can be done beyond the adaptation of a well-fitting urinal to keep the patient dry.

Irritability, Spasm, and Neuralgia of the Bladder (*Cystalgia*) are often spoken of as distinct diseases, but are usually merely symptomatic of other conditions, such as cystitis, tumor or fissure of the bladder, or vesical calculus. The *treatment* must be addressed to the relief of the pathological condition to which the symptoms are due, when this can be ascertained.

Anodynes and antispasmodics are often useful as palliatives. Lund and Teale recommend, in cases of females, rapid dilatation of the urethra, and report several instances in which this mode of treatment gave entire relief. The same operation has been successfully resorted to by other surgeons, and in three cases, in my own hands, afforded complete relief from the distressing symptoms which had been complained of. In the case of the male urethra, benefit may be derived from rapid dilatation with metallic sounds, or with Thompson's stricture expander, or resort may be had to division of the vesical neck in front of the rectum, as successfully practised in two cases by Verneuil.

INFLAMMATORY DISEASES OF THE PROSTATE.

Acute Prostatitis.—Acute inflammation of the prostate usually follows urethritis, especially when due to gonorrhœa, but may also result from various forms of injury, as from the introduction of instruments or the use of strong injections, from exposure to cold and moisture, as from sitting in wet grass, from previously existing cystitis, or from vesical calculus. As a complication of urethritis, it is apt to be excited by the use of alcoholic stimulants or by excessive venery. The *symptoms* of acute prostatitis are pain and weight in the perineum, with great frequency of micturition, dysuria, and vesical tenesmus, the pain also being increased by the act of defecation. There is a good deal of constitutional disturbance, and the swelling is sometimes so great as to induce complete retention of urine. The *diagnosis* can be readily made by rectal exploration. The inflammation may terminate in resolution, or may run on to the formation of an abscess, which usually bursts into the urethra; even if resolution occurs, however, the urine will probably contain pus, from the coexistence of cystitis. The *treatment* consists in the enforcement of rest and the administration of laxatives, with the application of leeches or cups to the perineum, followed by hot hip-baths and poultices. Pain may be relieved by the use of anodyne enemata. Should complete retention occur, it may be necessary to use the catheter.

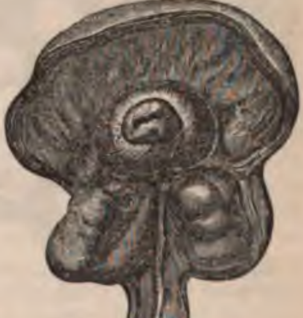
Abscess of the Prostate usually occurs as a sequel of acute prostatitis, but may be developed in an insidious manner from bruising of the part in the use of instruments, etc. In the latter cases, it is often the areolar tissue around the prostate which is affected, rather than the organ itself, and the affection is then called *peri-prostatic abscess.* Pointing usually occurs, as already mentioned, in the direction of the urethra, but occasionally towards the rectum, or even externally in the perineum. The symptoms are those of deep-seated suppuration in general, and the diagnosis can be made by rectal exploration. Retention is apt to occur when the swelling is principally on the side of the urethra, and the introduction of the catheter may then serve the double purpose of opening the abscess and evacuating the contents of the bladder. When the swelling makes its appearance in the perineum, an early and free incision is required, to relieve tension and prevent the formation of a rectal or urethral fistula. If fluctuation is distinctly felt in the rectum, it will be proper to make a puncture in that locality. Prostatic abscesses usually heal without much difficulty, but occasionally fall into a chronic state, persisting as suppurating cavities which form receptacles for urine. This condition is often not recognized during life, the symptoms closely resembling those of chronic cystitis. Benefit may sometimes be derived from the application of a weak solution of nitrate of silver.

Chronic Prostatitis or Prostatorrhœa.—This may be a sequel of acute prostatic inflammation, or may occur as a primary affection, resulting from the urethritis which accompanies organic stricture of long standing, from bruising of the perineum in equestrian exercise, from inordinate indulgence in sexual intercourse, from onanism, or from piles, habitual constipation, etc. The *symptoms* are pain and weight in the region of the prostate, increased during micturition or coitus; diminution in the force with which the urine is evacuated; a slight, thin, gleety discharge, sometimes in sufficient quantity to discolor the clothing; and usually the presence of a little pus in the urine, with occasionally a few drops of blood. Nocturnal seminal emissions occur in some cases. The affection is chiefly important on account of the mental distress it often occasions to patients, who believe the gleety discharge to consist of the seminal fluid. This is, perhaps, the most prominent symptom of the disease, and has suggested the name *prostatorrhœa*, which is employed by Prof. Gross, who has given an excellent account of the affection. The *diagnosis* between the prostatic fluid and semen can always be made by microscopic examination; the former contains very few, if any, spermatozoa, while these are, on the other hand, abundant in the latter. The *treatment* consists in removing any cause that can be detected, in the administration of tonics, especially phosphoric acid and strychnia (with laxatives, if required), and in the application of blisters or other counter-irritants to the perineum. In cases accompanied by nocturnal emissions, a solution of nitrate of silver (gr. v–x to f℥j), or, which is preferred by H. Lee, of the perchloride of iron (♏xv–xxx to f℥j), may be occasionally applied to the prostatic urethra, by means of a syringe with a catheter-like nozzle. Winternitz applies cold by passing a stream of water of a temperature from 55° to 60° Fahr. through a double-current catheter without eyes, which he calls a *psychrophor*.

CHRONIC HYPERTROPHY OF THE PROSTATE.

This is an affection of advanced life, being seldom if ever met with in men less than fifty years old, though inflammatory enlargement (a totally distinct condition) may of course exist at any age at which prostatitis itself is possible. So often is prostatic hypertrophy seen among those past the middle period of life, that Sir Benjamin Brodie considered it almost a normal condition under such circumstances; but the statistical investigations of Thompson, Messer, Lodge, and Dittel, have shown that its actual frequency is less than has been supposed, appreciable enlargement existing in but about one-third of the cases examined in persons more than sixty years of age.

FIG. 505.



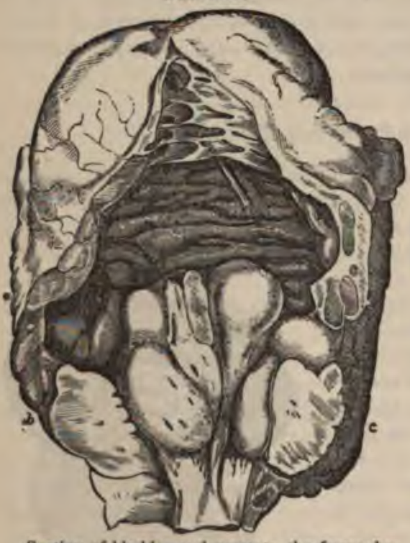
Enlargement of median lobe of prostate. (ERICHSEN.)

The hypertrophy may affect only the unstriated muscular fibres and connective tissue of the prostate, or may involve its glandular structure as well; there may be enlargement of the whole organ, or the increase of size may be confined to its lateral lobes, or to its central portion, constituting what is commonly called the enlarged "third lobe of the prostate." In many cases independent or semi-isolated tumors are found—principally in the lateral lobes—almost identical in structure with the prostate itself, though containing less glandular tissue, and that imperfectly developed; these prostatic tumors, which have been specially studied by Thompson, are sometimes surrounded by a fibrous capsule, and may often be readily enucleated with the finger, as has been done in the operation of lithotomy (see p. 910); they are in many respects analogous to the fibrous or fibro-muscular growths (*myomata*) met with in the uterus.

Physical Characters.—The *weight* of an hypertrophied prostate may vary from one to twelve ounces, and its *size* from two to four inches transversely, and from one to three inches in an antero-posterior direction. The *consistence* may be firmer or softer than in the normal condition, the increased firmness being usually attributable to the presence of the prostatic tumors which have been referred to.

Hypertrophy of the prostate produces various changes in the *form and direction of the prostatic portion of the urethra;* this is increased in length and often rendered tortuous; it is usually contracted laterally, and widened from before backwards, so that on making a transverse section it appears as a narrow chink instead of a round tube; but in other cases, this portion of the urethra is dilated into a pouch which may hold an ounce or two of the urine. When the central portion or "third lobe" of the prostate is enlarged, the urethra is commonly bent forwards at an angle—its course being thrown also to the right or left if either lateral lobe is increased in size, and the deviation being to the side *opposite* to that of the principal enlargement. The *internal orifice* of the urethra usually assumes a crescentic shape, the concavity of the crescent corresponding to that lobe of the prostate which is principally affected; but if the whole organ be irregularly enlarged, the urethral opening is much and curiously distorted. A projecting portion from the median lobe not unfrequently hangs over the orifice in a valve-like manner, closing it more or less completely when the patient attempts to urinate. Another mode in which the urethral orifice may be occluded, is by the formation of a *bar* at the neck of the bladder from the elevation of the mucous and submucous tissues by enlargement of the lateral lobes (see p. 932).

FIG. 506.



Section of bladder and prostate, the former hypertrophied, the latter forming prominent tumors within the bladder. (THOMPSON.)

In the large majority of cases, hypertrophy of the prostate interferes with the complete evacuation of the contents of the bladder in one of the ways mentioned, leading to a thickened, roughened, and sacculated condition of that organ, which becomes slowly distended and falls into a state of atony attended with habitual overflow of urine; under these circumstances, a very slight cause, such as exposure to cold, or local congestion produced by alcoholic indulgence or sexual emotion, may be sufficient to produce an attack of complete retention. On the other hand, it occasionally happens that the median, projecting between the lateral lobes, keeps the urethral orifice constantly patulous, thus giving rise to true urinary incontinence (p. 935). In cases of long standing, the ureters and pelves of the kidneys often become dilated, and chronic renal disease supervenes.

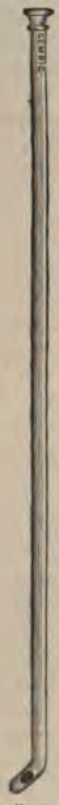
Symptoms.—The early symptoms of enlarged prostate are diminution of the force with which the contents of the bladder are expelled, the stream, though perhaps not smaller than in health, being feeble and slow, and tending to drop vertically from the meatus. The patient has to strain at the beginning of micturition, and the process requires a longer time than usual, because the bladder is in a state of partial atony; as the organ, moreover, is never completely emptied, the desire to make water recurs with undue frequency, and the normal sense of relief is not experienced from the act of urination; the water continues to dribble after the discharge of all that can be voluntarily evacuated, and particularly at night when the control of the will is withdrawn. There is a feeling of weight and distension about the perineum, with irritation of the rectum, tenesmus, piles, or prolapsus; and ultimately the symptoms of chronic cystitis are developed, with an ammoniacal state of the urine, and perhaps the formation of phosphatic calculi.

Diagnosis.—Hypertrophy of the prostate may always be recognized by careful exploration with the catheter, aided by the finger in the rectum; in this way the surgeon can ascertain not merely that the prostate is enlarged, but can determine approximatively the degree of hypertrophy, which lobe or lobes are particularly affected, and the direction in which the urethra deviates from its normal course. The ordinary catheter frequently will not reach the bladder, on account of the elongation and altered direction of the prostatic urethra which have been referred to: hence the surgeon should have at hand some *prostatic catheters*, which are from two to four inches longer than the ordinary instruments, and have a larger curve (Fig. 508). Rectal exploration will also enable the surgeon to ascertain if the distended bladder can be felt beyond the prostate—an important point in case the question of puncturing the organ for relief of retention should arise.

By conjoined urethral and rectal exploration, the surgeon can distinguish prostatic hypertrophy from *paralysis* or from *simple atony of the bladder*, from the *bar* at the neck of the organ unconnected with prostatic disease, and from *chronic cystitis;* the diagnosis from *stricture of the urethra* may be made by observing the *locality* of the obstruction (which in stricture is rarely more than six, and in prostatic hypertrophy at least seven, inches from the meatus), and the different *characters of the stream*, which in stricture is small and often forked, but is not always reduced in force, and sometimes keeps its normal parabolic curve, while in prostatic obstruction, though perhaps not diminished in size, it is always weak, and tends to drop vertically from the meatus. The diagnosis from *calculus* may be made by careful exploration with a sound; but it must not be forgotten that calculus and prostatic disease often coexist. *Acute prostatitis* can be recognized by rectal exploration alone, through the pain which is thus excited; while the catheter alone will show whether or not there is *atony of the bladder*, the flow when the obstruction is overcome being forcible and partially under the control of the will, when this organ is healthy, but weak and totally uninfluenced by volition, if it be in a condition of atony. This circumstance will of itself suffice to distinguish simple atony from prostatic obstruction. *Tumor of the bladder* is to be diagnosticated by observing the presence of blood and of fragments of the morbid growth in the urine, and by careful instrumental exploration (see pages 931 and 932).

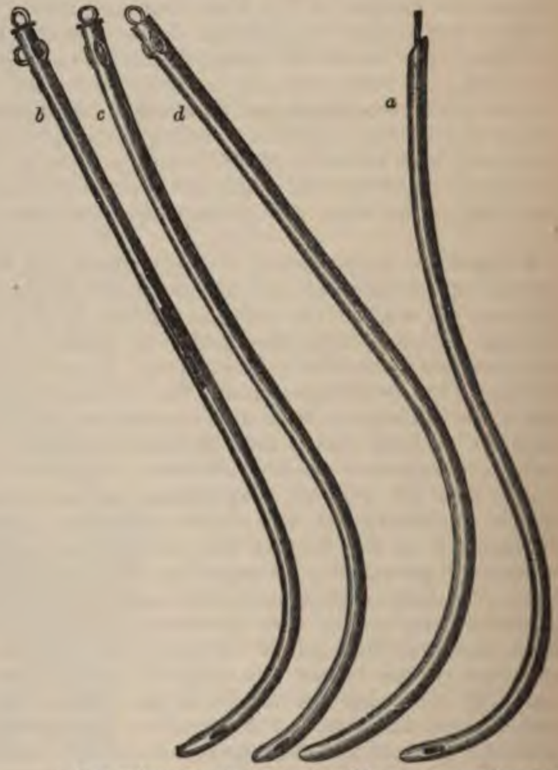
Treatment.—The most important point is to obviate the effects of obstruction, by emptying the bladder at suitable intervals by catheterization. Twice a day—morning and evening—is usually often enough, but the frequency with which the instrument is used must depend upon the degree in which obstruction is present. The patient should be taught to pass the instrument for himself, the best form for ordinary use being the "English" gum-elastic catheter, which should be kept, as advised by Brodie and Thompson, on an over-curved stylet (Fig. 508, *a*), so that, when this is removed, it may pass readily into the bladder. For special cases it may be necessary to use silver instruments, some of which should have a large curve—a third of the circumference of a circle the radius of which is 2¾ inches—and others a short beak like a lithotrite, which form of instrument is known as the *elbowed catheter* (*sonde coudée*); flexible catheters of the same form are also useful, and are known as Mercier's (Fig. 507). In other cases it may be necessary to use the gum instrument *with the stylet*, so that the curve may be altered at will, or so that the curve may be increased when the catheter reaches the point of obstruction, by partially withdrawing the stylet, in the way recommended by Hey, of Leeds. An ingenious instrument for use in cases of retention of urine from prostatic enlargement, has been devised by Dr. Squire, of Elmira, under the name of vertebrated catheter; its con-

FIG. 507.



Mercier's elbowed catheter.

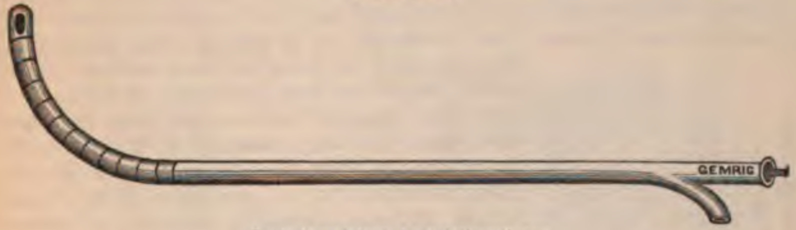
FIG. 508.



a, Gum catheter mounted on a stylet of the proper curve for use in cases of prostatic obstruction; *b*, *c*, *d*, silver prostatic catheters of different curves.

struction can be seen from Fig. 509. Dr. Cowan, of Danville, uses a soft gum catheter containing a spiral coil of brass wire, so as to give sufficient firmness to the instrument without interfering with its elasticity; somewhat similar instruments are employed by Dr. Otis and Dr. Keyes, of New York, and by Dr. S. W. Gross, of this city. If it should be necessary to leave a catheter in the bladder—which should, as a rule, only be done in cases of retention in which the introduction of the instrument has been attended with great difficulty—the vulcanized India-rubber catheter should be chosen, and may be introduced with or without the stylet, as may be found most convenient; if the stylet is used, it is, of course, to be withdrawn as soon as the instrument is in place. The cathether may be most conveniently secured by means of adhesive strips, reaching from the instrument to the penis, and fastened to the latter by other strips applied circularly around the organ. Care must be taken not to produce so much constriction as to lead to ulceration or sloughing. *Self-retaining catheters* have been devised by several surgeons, but, I confess, have always seemed to me more ingenious than practically useful.

FIG. 509.



Squire's vertebrated prostatic catheter.

Beside periodically emptying the bladder by the use of the catheter, the surgeon must pay great attention to the general condition of the patient, who should live temperately, dress warmly, and take moderate walking exercise in the open air. The treatment of cystitis with vesical catarrh, a frequent complication of enlarged prostate, has already been referred to. Various drugs, particularly conium, mercury, muriate of ammonium, and iodine, have been employed in the hope of causing absorption of prostatic enlargement, and systematic compression[1] (first proposed by Physick) has been used for the same purpose: none of these remedies have, however, sustained the reputation which was claimed for them, and they are now generally abandoned. Various operations, such as incision, excision, cauterization (the use of the galvanic cautery has been lately recommended by Bottini), avulsion, strangulation with the ligature, crushing with a lithotrite, etc., have also been suggested, but do not appear to offer any hope of benefit commensurate with the risk which they entail. Prof. Gross speaks highly of the occasional application of leeches to the perineum. Heine recommends the injection of tincture of iodine, and Langenbeck and Iversen that of ergotine, the injections being given through the rectum. Heine's method has been successfully employed by Dr. Melville Taylor, of Maryland, but, according to Dr. B. Howard, several cases thus treated by Dittel, of Vienna, terminated in suppuration and death. The internal administration of ergot is advised by Atlee, of this city, and by Satterthwaite, of New York. Sir

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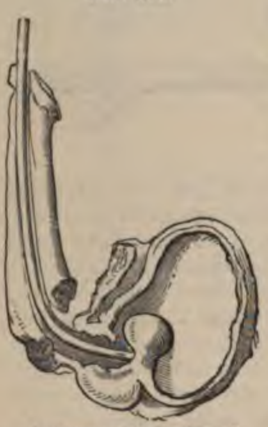
[1] Harrison, of Liverpool, advises compression (with an olivary bougie) as a means of *preventing* obstruction, by *moulding* the prostate as it grows, in such a way as to prevent occlusion of the urethra.

Henry Thompson advises that, in cases which require the very frequent use of the catheter, an opening should be made above the pubis, and a flexible tube introduced, and permanently retained in position. A similar plan has been recommended by Dittel, and by Keyes, of New York, and in one case in which I tried the operation it certainly afforded very great relief.

TREATMENT OF RETENTION FROM PROSTATIC OBSTRUCTION.

If complete retention occur, the surgeon may try the effect of a hot bath with a full dose of opium; but if this fail (as it usually will), persevering attempts must be made to pass a catheter. The patient should be in a recumbent position, for if erect, fatal syncope might occur from the rapid withdrawal of a large quantity of fluid (as in the operation of tapping the abdomen), and the surgeon should then try in succession, with all gentleness, however, prostatic catheters of various kinds and shapes, until, if possible, relief is afforded, when, if thought proper, the instrument may be fastened in the bladder. If the distension has been very great, it may be prudent to remove only a portion of the urine at a time (see page 934). The chief points to be attended to in catheterization, in these cases, are (1) to firmly depress the extremity of the instrument between the patient's thighs, so that its beak may ride over the enlarged third lobe into the bladder, and (2) to make sure that the bladder is actually reached, and that the catheter does not merely enter the elongated and dilated urethral pouch which often exists in cases of prostatic enlargement.

FIG. 510.



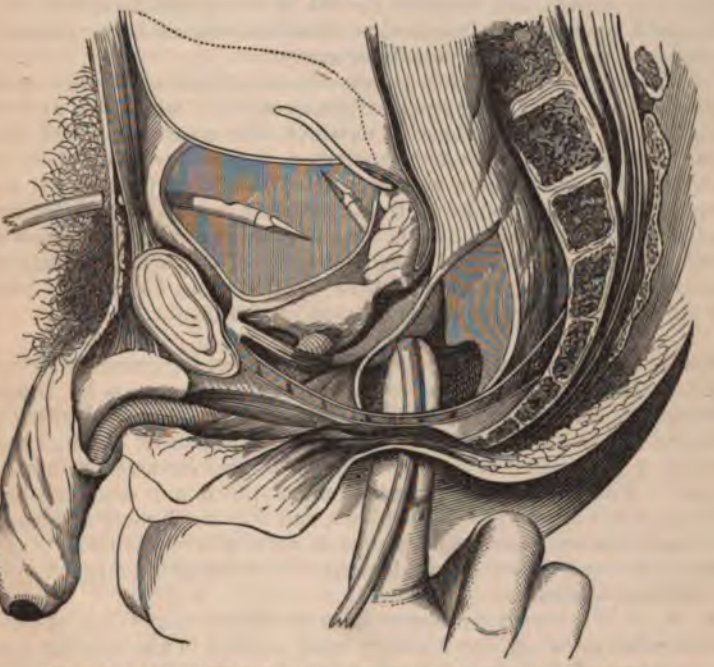
Catheterization in enlarged prostate. (ERICHSEN.)

If catheterization cannot be accomplished, the bladder must be punctured in one of four ways, viz., (1) through the prostate; (2) through the rectum; (3) above the pubis; or (4) through or below the pubic symphysis.

Puncture through the Prostate (*Tunnelling the Prostate*).—This operation was recommended by Home, Brodie, and Liston, the two former surgeons simply perforating the obstruction by pushing through it a silver catheter, while the latter employed a large and slightly curved canula carrying a concealed blade. The surgeon first satisfies himself that the instrument is exactly in the median line, and has not deviated from the urethra, and then pushes it steadily onwards while he depresses its handle, until the cessation of resistance and the flow of urine show that the bladder has been reached. A false passage is thus made through the projecting third lobe of the prostate, and in this false passage the instrument should be left for about forty-eight hours, when the parts will usually be sufficiently consolidated to allow the catheter to be withdrawn and re-introduced as often as necessary. This mode of treatment is by no means free from risk, and should never be resorted to unless the surgeon can positively satisfy himself that his instrument has not left the channel of the urethra, and that it impinges directly upon the obstructing portion of the prostate. Under other circumstances the bladder might not be reached at all, and the operation would probably be followed by the most serious consequences. Harrison, of Liverpool, recommends tapping through the prostate, from the perineum, with a trocar and canula, the latter of which is retained in position, and reports a case in which this operation was resorted to with most gratifying results, the size of the prostate rapidly diminishing after the operation, and a radical cure being thus ultimately effected.

Puncture through the Rectum is not applicable to cases of very great prostatic enlargement. If, however the fluctuation of the distended bladder can be distinctly recognized above the prostate, by digital exploration through the rectum, this operation may be safely resorted to, as the puncture can then be made below the recto-vesical fold of peritoneum. The patient being in the lithotomy position, the bladder is steadied and pressed downwards by an assistant placing one hand on either side of the abdomen; the surgeon, then, having satisfied himself as to the extent and relations of the prostate, introduces upon the left forefinger, which serves as a guide, a curved trocar and canula, seven or eight inches in length, and by depressing the handle of the instrument carries its point through the contiguous walls of the rectum and bladder, the cessation of resistance showing when the latter organ has been entered. The trocar is then carefully withdrawn, and the canula secured in place by means of tapes fastened to a bandage around the waist. After a few days, probably, the catheter can be introduced without difficulty, when the rectal canula may be taken out, the wound usually closing without any trouble. The risks of rectal puncture, apart from *wound of the peritoneum* (which can scarcely occur if the operation be reserved for cases in which vesical fluctuation is distinctly recognized by the finger in the rectum), are *injury of the seminal vesicle*, *abscess of the recto-vesical septum*, leading perhaps to *urinary infiltration*, and the formation

FIG. 511.



Puncture of the bladder through the rectum, and above the pubis. (PHILLIPS.)

of a *recto-vesical fistula*. *Emphysema* has occasionally followed the operation. The statistics of rectal puncture have been investigated by Deneffe and Van Wetter, who have collected 97 cases, with 86 recoveries and 11 deaths.

Puncture above the Pubis.—The bladder may also be safely tapped above the pubis (in which position it is uncovered by peritoneum), by making a small incision in the median line just above the symphysis, and then introducing a straight or slightly curved trocar and canula (with the convexity upwards) in a direction downwards and backwards, so as to penetrate the bladder: the canula may be left in for two or three days, after which a gum-elastic tube may be substituted—the latter instrument being subsequently renewed as often as may be found necessary.

Dr. Dieulafoy, of Paris, has suggested a modification of this operation, by which the bladder is emptied by means of the "aspirator," and numerous cases have now been recorded in which this operation, which does not appear to be attended with any particular risk, and which I have myself employed with satisfaction, has been successfully performed. It has the advantage over other modes of treatment, that it may be repeated as often as necessary, and therefore does not require the retention of an instrument. Deneffe and Van Wetter find that 152 cases of the ordinary supra-pubic puncture gave 125 recoveries and 27 deaths, while 55 cases of puncture with the aspirator gave 52 recoveries and only 3 deaths.

Puncture through the Symphysis Pubis was first suggested by Brander, of Jersey, in 1825, and has since been successfully resorted to by Leasure, of Pennsylvania, and several other surgeons. It is accomplished with a strong hydrocele trocar and canula, by pushing the instrument through the symphysis in a direction "obliquely downwards and backwards towards the sacrum." This mode of treatment is only applicable to cases in which the cartilage of the symphysis is unossified, and does not appear to present any advantage over the supra-pubic puncture, particularly when the "aspirator" is employed; and the same may be said of the **sub-pubic** mode of operation attributed to Voillemier.

Dr. W. R. Whitehead recommends, as preferable to any form of puncture, a supra-pubic *cystotomy*, the bladder being opened in the median line, and the cut edges of the viscus attached by silver sutures to the edges of the external wound.

OTHER DISEASES OF THE PROSTATE.

Atrophy of tho Prostate is occasionally observed either as a congenital or as an acquired affection. The prostate may be considered as atrophied whenever its weight (in an adult of medium size) is less than half an ounce. The affection presents no special symptoms and requires no special treatment.

Cancer of the Prostate is usually of the encephaloid variety, though, according to Jolly, true scirrhus is occasionally found in this organ. The affection, which is one of great rarity, may occur either in early childhood or in late adult life; the *symptoms* are those of prostatic obstruction, with pain, hæmaturia, glandular implication, and, ultimately, general cachexia. The *diagnosis* is almost impossible during the early stages of the disease; and, indeed, according to Jolly, has rarely been made during the life of the patient. The *treatment* must be purely palliative, and instrumental interference should be, if possible, avoided. If absolute retention occur, puncture of the bladder may be required as a means of prolonging the life of the patient, though, of course, ultimate recovery is impossible. For further information on the subject of prostatic cancer, the reader is referred to the writings of Gross and Thompson, and especially to an elaborate and exhaustive memoir published by Jacques Jolly, in the numbers of the *Archives Générales de Médecine* for May, June, July, and August, 1869.

Tubercle of the Prostate occurs in connection with tubercle of other organs, but presents no special indications for treatment.

Cysts of the Prostate are of the kind called by German pathologists *retention cysts*, resulting from obstruction of the glandular tubes of the organ by calculous concretions; they are seldom recognized during life, but in one instance, recorded by Lansdowne, the cyst attained so great a size as to cause retention of urine. In this case the cyst was punctured through the rectum, and suppuration followed, resulting in the entire recovery of the patient. Lowdell has observed a true hydatid cyst in this locality.

Prostatic Calculi have already been referred to at page 919.

CHAPTER XLVI.

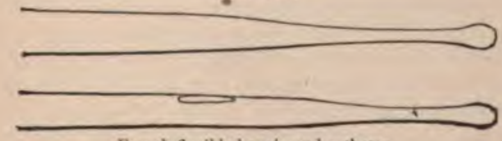
DISEASES OF THE URETHRA AND URINARY FISTULA.

EXPLORATION OF THE URETHRA.

THIS is accomplished by the aid of *catheters, bougies,* or *sounds,* and may be aided in some cases by the use of the *endoscope.* Catheterization of the urethra is an operation which is very frequently required, and in the performance of which every surgeon should strive to acquire such skill as to inflict the least possible amount of pain upon his patient.

Catheters.—These are hollow tubes, made either of metal—when they must have a curve corresponding to that of the normal urethra—or of India-rubber, or other flexible substance. There are two principal varieties of flexible catheter in the market—the *English* and the *French.* The former is of a yellowish-brown color, and is provided with a stylet; it can be made of any curve the surgeon chooses, by moulding it in hot water and then quickly plunging it into cold water, when it becomes stiff, and will retain its curve long enough to allow its introduction in all ordinary cases. The French instrument, of a black color, is, on the contrary, perfectly flexible, bending with the utmost facility in every direction; it is conical towards its

FIG. 512.

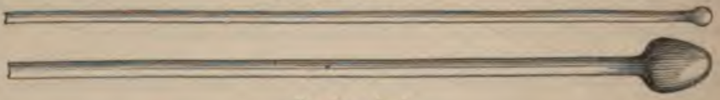


French flexible bougie and catheter.

extremity, and terminates in an olive-shaped point, to prevent its catching in the lacunæ of the urethra. Another form of French catheter, known as Nélaton's, is made of thin India-rubber, and is chiefly employed when it is desired to keep an instrument constantly in the bladder (*sonde à demeure*). A catheter should be ten or eleven inches long, and provided with one or two large, smoothly finished eyes near its vesical extremity; the *metallic* instrument should be heavily silver or nickel plated, and should have rings at its outer end to enable the surgeon to judge, by their position, of the exact situation of the beak of the instrument, when it is in use. The *curve* of a catheter should correspond to that of the normal urethra; the instrument employed by Thompson has a curve which forms a quarter of the circumference of a circle with a radius of one and five-eighths inches (three and a quarter inches in diameter). Béniqué's instrument, which is preferred by Bumstead, has the same curve, but occupies a greater arc of the circle. The curve of the catheter should be continued *quite up to its point*. The *sizes* of catheters are arranged by either the English, American, or French scale—the latter being the best, as having more numbers, and therefore allowing more nicety of graduation. The English scale runs from one to twelve, the American from one to twenty, and the French from one to thirty, the numbers in the latter representing the *circumference* in millimetres.[1] For purposes of exploration, or for ordinary use, a medium-sized catheter should be chosen, as it is less likely to inflict injury than a smaller one, and will not be caught in the lacunæ of the urethra. A *double-curved* or S catheter is a convenient form of the instrument for office use. Hueter, of Greifswald, employs flattened catheters, which he considers easier of introduction than those of the ordinary form.

Bougies and Sounds.[2] — These may be regarded as *solid catheters*. The *bougie* (originally made of wax, whence the name) is a flexible instrument, and there are two varieties, corresponding to the English and French catheters. Beside the ordinary conical, olive-pointed French bougie,[3] the surgeon should have some of the kind which go under the name of *bougies à boule*, or, as Bumstead more accurately terms them, *acorn-pointed bougies*. These are particularly valuable for purposes of exploration, enabling the surgeon to judge of the extent of a stricture by noting the point at which resistance is felt, both upon the introduction and upon the withdrawal of the instrument. Care must be taken, however, not to mistake for stricture the normal narrowing of the urethra in the region of the triangular ligament, at which point, as shown by Dr. J. Wm. White, of this city, the bulbous-pointed

FIG. 513.



Bougies *a boule*.

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[1] Strictly speaking, the numbers of the French scale represent the *diameter* in *thirds of a millimetre*; the ratio of diameter to circumference is not precisely 1–3, but 1–3.1415926; the statement in the text, however, is sufficiently accurate for practical purposes.

[2] Or *urethral sounds*, in contradistinction to the *vesical sounds* used for exploring the bladder.

[3] To obtain an instrument intermediate in firmness between an ordinary bougie and a sound, Thompson suggests the introduction into the former of a leaden stylet, which terminates about four and a half inches from the extremity of the instrument.

bougie is apt to be arrested when it is being withdrawn. *Filiform* bougies are simply bougies of a very small size; they may be made of whalebone, or of the same material as the ordinary French bougie or catheter, the latter being upon the whole the best. These instruments are indispensable for the treatment of tight strictures.

Sounds are made of steel, pewter, or other metallic substance, and should be perfectly smooth and highly polished, or, which is better, plated with silver or nickel. Their curve should be that of a well-made metallic catheter, and they should have a broad handle to prevent them from slipping when in use. Their sizes are graduated by the same scale as catheters. Sir C. Bell employed a *bulbed sound* for purposes of exploration, and Richardson, of Dublin, has recently devised an ingenious instrument, the extremity of which is formed by the approximation of two half-bulbs, which are introduced closed, and can be divaricated after passing the stricture, thus clearly marking the posterior limit of the contraction as the instrument is withdrawn.

Introduction of the Catheter.—The patient may be in a standing,[1] sitting, or lying posture, the last being much the best under ordinary circumstances. He should lie perfectly flat on his back, with the shoulders slightly elevated and the thighs somewhat flexed and separated; the drawers should be slipped down, and the shirt tucked up so as to fully expose the genital organs. The surgeon, sitting or standing on the left side of the patient, raises the penis with his left hand, and, holding the catheter or sound (previously warmed and oiled) lightly between the thumb and two fingers of the right hand, introduces its beak between the lips of the meatus, its shaft being nearly horizontal and lying in the direction of the fold of the patient's left groin. The penis being steadied and slightly drawn upwards so as to efface the folds of the urethra, the instrument is very gently pushed onwards, entering almost by its own weight, and being "swallowed," as it were, by the canal, until the beak has passed beneath the symphysis pubis. During the first two inches of its course the catheter should be kept to the floor of the urethra, so as to avoid the lacuna magna, but should afterwards be made to cling to the roof of the canal, to avoid the sinus of the bulb and the openings of any false passages that may be present. When the point of the catheter has passed beneath the pubis, the shaft is to be brought into the median line and slowly elevated to a vertical position, when, by gently depressing the handle between the patient's thighs, supporting at the same time the convexity of the instrument by pressing on the perineum or with the finger in the rectum, the beak will glide into the bladder. If any difficulty be experienced, the instrument should be slightly withdrawn, and re-advanced with its point held more closely to the roof of the canal.

The points requiring special attention are, to avoid the lacuna magna, to keep the handle of the instrument down until its point is well beneath the pubis, and to combine the progressive and curving motions in a slow and gentle sweep, so that the beak of the instrument may follow the normal course of the urethra, which the surgeon must constantly bear in mind. Above all, the surgeon must avoid the use of force. If the resistance be from spasm, this will yield to very gentle pressure; if from congestion and engorgement of the prostate, from excessive development of the uvula vesicæ, or from the presence of a bar at the neck of the bladder, it may be necessary to employ a prostatic catheter; while if from organic stricture, a smaller instrument must be used. Under no circumstances should the surgeon attempt to overcome the obstruction by violence, for the walls of the urethra are readily lacerated, and a false passage is very easily made; whereas, in the words of Sir Henry Thompson, "temper, patience, and a light hand will overcome almost all cases of difficulty." Instead of oiling the catheter, it is sometimes better to *distend the urethra* with oil, thrown in with an ordinary penis-syringe.[1]

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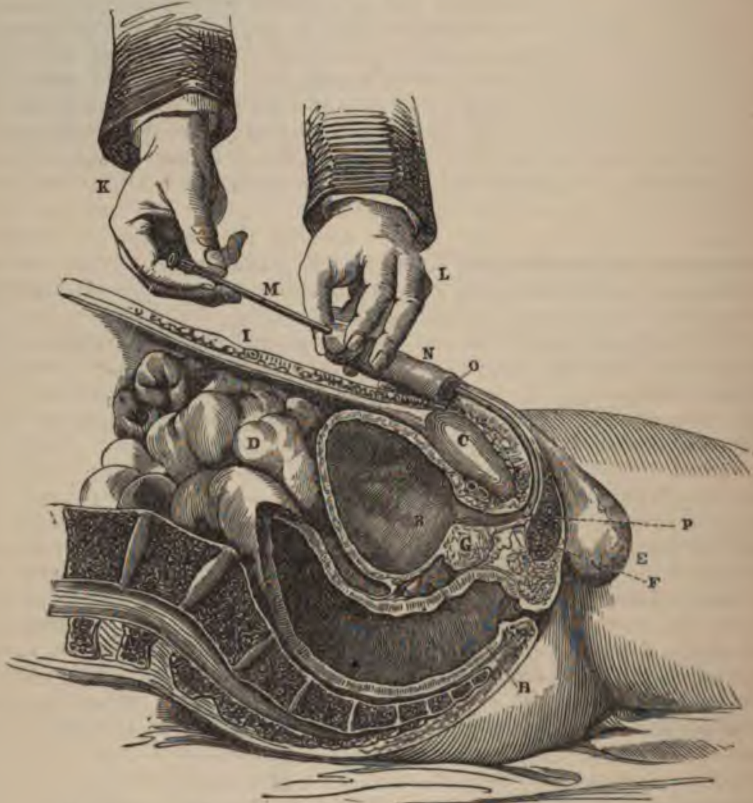
[1] Gay advises the standing posture, and directs the patient to make a straining effort at micturition, so as to overcome any tendency to spasm.

FIG. 514.



Introduction of the catheter. (VOILLEMIER.)

If the patient be very fat, difficulty may be experienced in bringing the catheter to the median line of the body without prematurely elevating its handle, and under these circumstances a manœuvre known as the "*tour de maître*" should be adopted. This is, indeed, a very convenient mode of catheterization, and I often employ it instead of the ordinary method. The surgeon stands on the right side of the patient, and introduces the catheter with its convexity upwards and its shaft lying obliquely across the patient's left thigh; as the point of the instrument reaches the bulb, the handle is swept around towards the abdomen—when the beak enters the membranous portion of the urethra, and is carried into the bladder by depressing the shaft between the patient's thighs in the way already described.

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[1] Dr. Tytler, of Manchester, suggests *inflation* of the urethra, either with Politzer's bag or by the successive injection of carbonate of sodium and tartaric acid.

One or other of these plans is to be adopted in using metallic catheters or sounds, and English flexible catheters and bougies. To employ either of the latter with satisfaction, the surgeon must have at hand two basins, one of hot water and the other of cold. The instrument is moulded to the proper curve in the first, and then instantly plunged into the other, by which method its curve is fixed and will remain unchanged long enough for ordinary purposes. If, however, there be much delay in the introduction, the warmth of the urethra will again soften the instrument, and it will lose its curve. The English catheter should, as a rule, be used *without the stylet.* The object of the latter is not to aid in the introduction of the instrument, but to enable the surgeon to give it a permanent curve by keeping it on the stylet when not in use. When the catheter without the stylet is not sufficiently firm, a metallic instrument will commonly be safer and more efficient. If, however—in a case of enlarged prostate, for instance—it be necessary to leave the catheter in the bladder, the metallic instrument is undesirable, and it may then be necessary to introduce the flexible catheter with the stylet, the latter being, of course, withdrawn as soon as the catheter is in place.

The French instrument is introduced by simply pushing it gently in the line of the urethra. It is impossible to guide its point, which will, however, unless in cases of great obstruction, readily find its own way into the bladder. The French catheter is, unfortunately, a perishable form of instrument, and is with difficulty kept in order in warm climates.

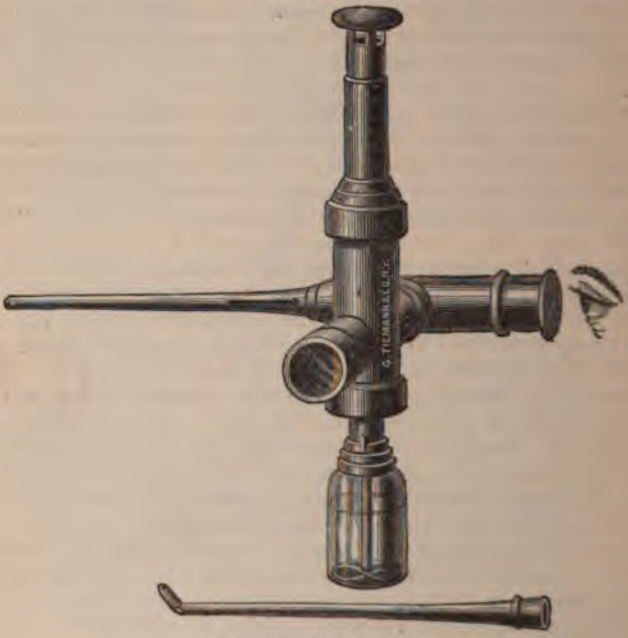
A great difference of opinion prevails among surgeons as to which is the best, the flexible or the metallic instrument; it is commonly said that, though a gum catheter may be the safest in the patient's own hands, yet that, for the surgeon, an undeviating instrument is preferable; such was formerly my own opinion, but increasing experience has convinced me that Sir Henry Thompson is right in declaring that for all ordinary cases the flexible catheter is quite as easy of introduction as, and much less dangerous and painful to the patient than, the metallic. In dealing, however, with some very tight strictures, a silver catheter may undoubtedly be preferable to any other, while, again, in the later stages of dilatation, use may properly be made of finely polished conical steel sounds; in fact, in this as in most other departments of surgery, the practitioner will do wisely not blindly to follow one exclusive method, but to vary his remedies according to the exigencies of each particular case. Before using any catheter, whether flexible or metallic, the surgeon should carefully examine into the condition of the instrument; from neglect of this precaution the end may be broken off in the bladder, and form the nucleus of a calculous concretion.

Posterior Catheterization is a name employed by Volkmann for a mode of treatment advocated by Verguin, Hunter, Brainard, and Ranke, which consists in opening the bladder above the pubis, and passing a catheter through the wound and into the urethra from its vesical extremity.

The Endoscope.—This consists of a somewhat conical metallic tube, straight for the urethra, and beaked like a vesical sound for the bladder, with an eye-piece, an illuminating apparatus, and an arrangement of mirrors, by which a strong light can be thrown upon whatever touches the end of the tube. This mode of exploring the internal cavities of the body appears to have suggested itself to Borrini, in the beginning of this century, and subsequently to Segalas, Bombolzini, Fisher (of Boston), and Avery, but was first practically introduced to the notice of the profession by

Desormeaux; modifications of the instrument have since been proposed by Cruise, Warwick, Wales, and others, simplifying the apparatus, and permitting the employment of sunlight instead of artificial illumination. Though changes of color in the urethral mucous membrane are readily recognized with the endoscope, it has not been found to add much to the information which can be acquired by careful exploration with the sound or catheter, and has proved less useful in practice than was at first anticipated. Dr. Nietze, of Vienna, has devised an instrument which he calls a *cystoscope*, by means of which a platinum wire is rendered incandescent in the bladder, and a prism is so arranged as to reflect the appearances of the part, which the surgeon inspects through a tube or catheter. A somewhat similar contrivance, under the name of *polyscope*, had been previously employed by Trouvé.

Fig. 515.



Desormeaux's endoscope.

Malformations of the Urethra.

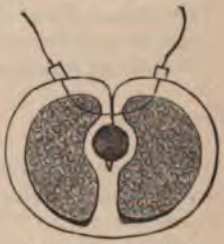
The urethra may be *partially* or *completely occluded*, or may be partially *deficient*, an abnormal opening existing on its upper or lower surface. When the opening is above, the deformity is called *epispadias*, and when below, *hypospadias*.

Partial Occlusion, or *Congenital Narrowing of the Urethra*, occurs at or near the external meatus; the treatment consists in restoring the calibre of the part by an incision with a probe-pointed bistoury, recontraction being prevented by the subsequent use of a bougie, or, as advised by Weber, by dissecting the skin from around the orifice, and then splitting and everting the mucous membrane which is subsequently attached by several points of suture, as in Ricord's mode of amputating the penis.

Complete Occlusion of the Urethra produces retention of urine which usually proves fatal within a few hours of birth: if the condition should be recognized during life, the occluding membrane, which is usually but a few lines in thickness, should be divided with a sharp bistoury or punctured with a trocar and canula, the opening being maintained by the occasional passage of a bougie. Should the point of occlusion be so far back as to render it impossible to reach it from the meatus, it would, I think, be the surgeon's duty to open the urethra behind the seat of obstruction, if this could be done from the perineum, or to puncture the bladder by one of the operations which have already been described.

Epispadias, or *Deficiency in the Roof of the Urethra,* may be complete or partial. *Complete epispadias* is seldom met with except in connection with exstrophy of the bladder; the latter deformity having been remedied in the way already described, the epispadias may be relieved by a plastic operation, as has been done by J. Wood (see page 926). *Partial epispadias* is but a lesser degree of the same deformity, the abnormal opening extending from near the pubes to the end of the penis; it may be treated in a similar manner, by turning down a narrow flap from the hypogastric region, and covering it in with a bridge of skin dissected from the scrotum. This operation, which originated with Nélaton in 1852, has been since repeated, both by himself, by Follin, and by J. Wood, with good results; it is the operation after which was modelled Richard's method of treating exstrophy of the bladder (see page 924). Another plan (Fig. 516), successfully employed by Duplay, consists in simply denuding raw surfaces on either side of the urethral floor, and then bringing them together over a catheter with a modified quill suture. Schröder, Mœricke, and other surgeons, have successfully operated in cases of epispadias in *women.*

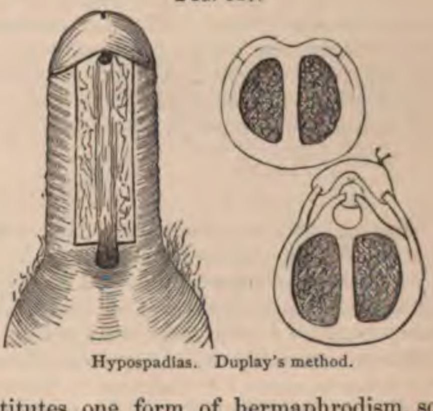
FIG. 516.



Epispadias. Duplay's method.

Hypospadias, or *Deficiency in the Floor of the Urethra,* is a comparatively common affection. The abnormal opening, which is usually much smaller than that of epispadias, is commonly found at the base of the frænum, more rarely at the point of junction of the penis and scrotum, and occasionally, it is said, in the perineum. Complete hypospadias, associated with cleft scrotum, constitutes one form of hermaphrodism, so called. When the opening is placed far back, the deformity, beside causing inconvenience in micturition, interferes with the ejaculation of semen, and thus renders the patient practically sterile; under these circumstances the malformation (which is usually unimportant) may call for surgical treat-

FIG. 517.



Hypospadias. Duplay's method.

ment, which consists in endeavoring to restore with knife or trocar the natural passage from the meatus to the urethra above the hypospadiac orifice—the latter being subsequently closed by a plastic operation such as will be described under the head of urethral fistula, or in making a new urethra by one of the ingenious operations devised by Bouisson, Moutet, Anger, and Duplay, of France; J. Wood, of London; and Gouley, of New York. Of these, the best are, I think, Wood's and Duplay's—Wood's consisting in inverting a flap from the lower surface of the penis and scrotum, and covering it in with a saddle-shaped flap taken from the prepuce, and Duplay's in inverting flaps from the lower surface of the penis and covering them in with others taken from the sides of the organ (Fig. 517), a dorsal incision being made if necessary to relieve tension, or—which the same surgeon now prefers—in making grooves merely on either side of the urethral roof, and covering this with side flaps held together over a catheter with a modified quill suture. In cases of glandular hypospadias with great contraction of the orifice, I have employed with much advantage Weber's operation for partial occlusion of the urethra. Duplay advises that in both epispadias and hypospadias, the operations for the formation of the new urethra should be undertaken at an early period, but that the last step—the closure of the abnormal orifice—should be postponed until the patient has attained the age of reason. Emmet has successfully operated in a case of deformity analogous to hypospadias, occurring in a young woman.

PROLAPSUS OF THE URETHRA.

This is said by Guersant to be a not unfrequent affection in female children. The prolapsus, which results from straining efforts in coughing or in defecation, or, as in a case recorded by Ingersley, in an attempt to stop laughing, forms a rose-colored tumor at the urinary meatus, apparently proceeding from the interior of the canal, but having in its centre an opening which admits the catheter and thus reveals the nature of the affection. If unrelieved, the prolapsus leads to vulvitis, and gives rise to a burning and smarting sensation in the act of micturition. The *treatment* recommended by Guersant is excision with curved scissors, hemorrhage being checked by the use of the perchloride of iron or ice. The galvanic or actual cautery is employed by Skene. Chamorro records a case occurring in an adult and at first mistaken for prolapsus of the womb. Rest in bed and the use of astringents rendered reduction possible. Streubel and Blum, and Sealy and Hudson, of New Zealand, have also observed the affection in adults, as has Emmet, who cured his patient by a plastic operation.

URETHROCELE.

In this affection, which is only met with in females, the wall of the urethra becomes much thickened, and forms a pouch which projects between the labia, allowing the retention of a considerable quantity of urine, and eventually leading to cystitis and ulceration of the bladder. The *treatment* recommended by Bozeman, who has given a good account of the affection, consists in tapping the cystocele at its most dependent point. Skene mentions a case cured by dilatation of the urethra and the injection of nitrate of silver. Gillette relieved his patient by denuding the anterior vaginal wall and bringing the edges of the wound together with stitches, while Lawson Tait was equally successful by cutting away the base of the sac, dissecting out its mucous lining, and then bringing together the edges of the vaginal wound. Other cases have been recorded by Foucher, Priestley, Simon, Thomas, and Duplay, the latter of whom cured his patient by laying open the sac with the galvanic cautery and repeated cauterizations with nitrate of silver.

URETHRITIS.

Inflammation of the Urethra may arise from injury, from gastric or intestinal disorder, from exposure to cold, from the contact of irritating injections, from an acid or ammoniacal condition of the urine (as in cases of long-standing stricture or prostatic enlargement), from onanism, from prolonged or violent coitus, or from contact with the menstrual fluid or with leucorrhœal or gonorrhœal discharges. Whatever its origin, its course and symptoms are the same, and it requires the same treatment. This has already been described at page 433.

SPASM OF THE URETHRA.

Spasm, or, as it is usually called, *Spasmodic Stricture of the Urethra*, rarely occurs except as a complication in cases of permanent or organic stricture, or in those of inflammation of the urethra. I do not mean to deny the frequent existence of muscular contraction in a healthy urethra, which is indeed often felt closing around a catheter or bougie, the canal, as it were, grasping the instrument; but it is very seldom, indeed (except in the cases mentioned), that this contraction is sufficient to materially hinder the flow of urine, or to impede the entrance of a catheter.

The chief *causes* of spasm, beside organic stricture and urethral inflammation, one or both of which are present in the large majority of instances, are (1) the irritation caused by the impaction of a calculus, by an acid or ammoniacal condition of the urine, or by certain substances which are eliminated by the kidneys, as the oil of turpentine, Spanish fly, and some varieties of wine or other liquor; (2) voluntary neglect to empty the bladder at the right time; (3) exposure to cold; (4) immoderate indulgence in coitus; (5) diseases of or operations on the lower bowel; and (6) disorders of the digestive apparatus or of the nervous system. To the latter cause is to be referred the urethral spasm, sometimes culminating in temporary retention, which occurs in the course of fevers, or after severe traumatic injuries or surgical operations. Usually an attack of spasmodic retention is traceable to a combination of causes; thus it not unfrequently happens that a patient with slight organic stricture, or slight urethral or prostatic inflammation, dining out or joining some party of pleasure, and indulging more freely than usual in the delights of the table, perhaps also neglecting to obey the call of nature at the proper time, finds at length, when an opportunity to empty the bladder is presented, that the power of micturition is gone. Slight spasm may occur at any part of the canal, but the common seat of the affection is at the membranous portion, from the action of the compressor urethræ muscles.

The *symptoms* of spasm of the urethra are the sudden occurrence of great diminution in the size of the stream, with great pain and straining in the act of urination, which is often accompanied with a feeling of weight and fulness in the perineum, and with irritation of the lips of the meatus, showing that with the spasm there exists a certain degree of urethral and prostatic inflammation.

The *treatment* varies according as there is or is not complete retention. In the latter case, relaxation of the spasm may usually be induced by the administration of an enema of laudanum, and by placing the patient in a warm bath, a full dose of castor oil being given as soon as the bladder is relieved. Another remedy which has acquired a good deal of reputation in these cases, is the muriated tincture of iron, given in doses of ten or twenty minims every quarter of an hour. The introduction of lumps of ice into the rectum is recommended by Cazenave and Teevan. The recurrence of spasm must be obviated by seeking for and removing the cause, and by attention to the state of the general health. When there is great acidity of the urine, alkalies may be administered, such as the bicarbonate of sodium, or the liquor potassæ, in combination with tincture of hyoscyamus and spirit of nitrous ether. If, as is usually the case, there is some permanent constriction of the urethra, this must be remedied by the systematic use of bougies.

In a case of complete retention of urine from spasm of the urethra, it is, I think, better to resort at once to the catheter. Apart from the patient's suffering, which is extreme, there is positive risk in allowing the bladder to remain distended; atony of this organ, or cystitis, with all its consequences, may result, or rupture of the urethra, or even of the bladder itself, may follow, leading to urinary extravasation, or even to fatal peritonitis. A rather small catheter—No. 11 or 12 (French)[1]—should be employed; and a gum-elastic is commonly preferable to a metallic instrument, as producing less pain. If catheterization fail, the patient should be put into a hot bath, opium administered, and (if there be much inflammation) leeches applied to the perineum, when the bladder will either relieve itself, or it will be found that the instrument can be readily introduced. Severer measures, such as opening the urethra in the perineum, or puncture of the bladder, can only be required when the spasm is a mere complication of tight organic stricture, or of decided enlargement of the prostate.

Brodie and Thompson have each recorded a case in which urethral spasm occurred periodically, and ultimately disappeared under the use of quinia.

Congestive Stricture.

The term is ordinarily, but incorrectly, applied to the temporary interference with the flow of urine which is due to inflammatory swelling of the prostate and adjacent parts. It is, in fact, a condition of subacute prostatitis, a disease which, as already mentioned, seriously impedes micturition, and occasionally produces absolute retention (p. 936). It is not unfrequently observed as a complication of gonorrhœa, caused by exposure to cold, or by imprudence of various kinds. (See p. 436.) When occurring in cases of organic stricture or enlarged prostate, spasm is often superadded. The *treatment* consists in the administration of laxatives, with laudanum enemata, and the hot bath. Leeches to the perineum will often be of service. If the urine be unduly acid, alkalies may be given, and strict attention should be paid to the state of the patient's general health. If gonorrhœa be present, this must be treated in the way described in previous pages, and benefit will often be derived, under these circumstances, from the occasional introduction of a bougie. The catheter may be required if absolute retention should occur.

Stricture of the Urethra.

Stricture of the urethra, or, as it is often called, in contradistinction to the temporary forms of obstruction last mentioned, *Permanent or Organic Stricture*, may result from long-continued urethritis (whether gonorrhœal or otherwise), from mechanical injury (*Traumatic Stricture*), or from the contraction which attends the healing of chancroidal or other ulcers. The congenital defect which has been already described as *Partial Occlusion of the Urethra*, is sometimes not detected until adult life, when it may, for all practical purposes, be regarded as a form of organic stricture.

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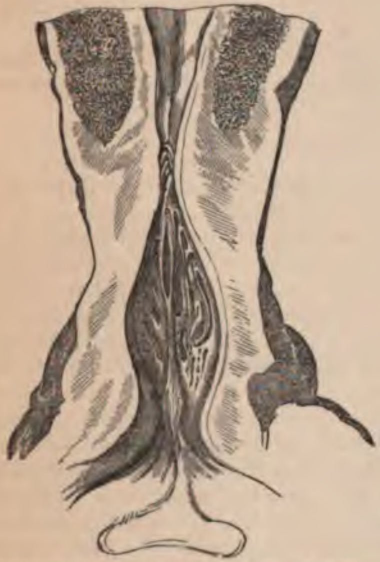
[1] The numbers given in this chapter refer to the French scale, or "Charrière-filière."

Age.—*Traumatic stricture* may occur at any age. I have seen one case in a boy of 11, who died from urinary extravasation following the giving way of the urethra behind the seat of stricture. This case, which was one of great interest, has been fully reported by Dr. Charles C. Lee, of New York.[1] The other forms of stricture, of which the *gonorrhœal* is by far the most common, are rarely, if ever, met with before the age of puberty; and, as several years usually elapse between the occurrence of the gonorrhœa and that of the stricture to which it gives rise, the latter is most commonly observed for the first time in men from 25 to 40 years of age.

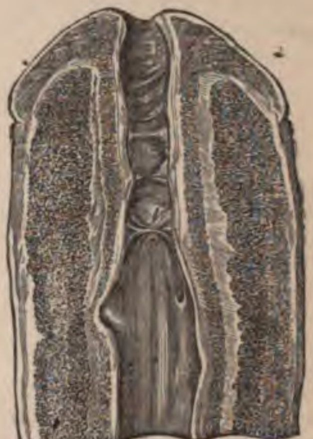
Locality.—The seat of stricture is, in the large majority of cases (over two-thirds), at the sub-pubic curvature of the urethra. This has been conclusively established by the laborious and careful investigations of Sir Henry Thompson. The most common position is at the posterior or bulbous part of the spongy portion of the canal (Fig. 518), the liability of the urethra to constriction diminishing as it is traced backwards. The next most frequent seat of stricture is at, or within two and a half inches of, the meatus, and after this comes the central part of the spongy portion. Stricture in the posterior part of the membranous portion is quite rare, while in the prostatic portion it very seldom, if ever, occurs, though the contrary has been maintained by eminent authorities.

FIG. 518.



Section of urethra, showing very narrow stricture, and dilated and reticulated membranous and prostatic portions behind it. (THOMPSON.)

FIG. 519.



Strictures near the orifice of the urethra. (THOMPSON.)

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[1] American Journ. of Med. Sciences, July, 1862, p. 108.

Number.—Usually—in more than three-fourths of all cases—there is but one stricture, but occasionally two or three distinct constrictions are found in the same urethra, and cases are described in which there are said to have been still larger numbers. When several strictures coexist, one is almost invariably found at the sub-pubic curve.

Morbid Anatomy.—The tissue chiefly affected is the submucous areolar tissue, which, as the result of the inflammatory process, becomes the seat of lymph-formation, partial organization following, and gluing together the mucous and submucous tissues, and often involving the substance of the corpus spongiosum. The contraction which ensues diminishes the calibre of the canal, often throwing the lining membrane of the urethra into folds or ridges, and at the same time lessens the natural elasticity of the part, and, of course, seriously impedes the exercise of its functions. Another form of stricture is described by some writers, as consisting in the deposit of a pseudo-membranous substance on the mucous membrane itself. Such a condition, if it exist at all, must be extremely rare.

Classification.—Strictures are variously classified, according to—1, their anatomical character; 2, the degree of contraction which they cause; and, 3, the symptoms which they present.

1. *Classification according to Anatomical Character.*—(1.) A *linear, bridle, pack-thread*, or *valvular* stricture is one in which the obstruction is produced by a thick fold of mucous membrane perforated in the centre, or forming a crescentic septum at one side only of the canal, or passing across from one side to the other in the form of an isolated band or bands. These bands or fræna are, according to Erichsen, probably formed artificially, by the perforation of a crescentic mucous fold with the point of a catheter.

(2.) An *annular* stricture resembles the variety last described, except in the circumstance that the canal is obstructed for a greater extent, the appearance being that which would be produced by tying a string or tape around the urethra.

(3.) *Indurated annular stricture* is the name given by Thompson to that form of constriction in which the tissues around the canal are indurated to the depth of from half a line to a line. The contraction is usually greatest at the central portion of the stricture, giving the part an hour-glass appearance. The induration is commonly most dense at the floor of the urethra.

(4.) *Irregular or tortuous strictures* embrace all the more complicated forms of the disease.

2. *Classification according to Degree of Contraction.*—A very important classification of strictures, as regards their treatment, is into *permeable* and *impermeable*. In one sense of the word, every stricture is permeable; that is to say, no stricture is so tight but that a drop or two of urine will occasionally find its way through;[1] but that every stricture which allows the passage of urine is, as has been asserted, necessarily permeable to a catheter or bougie, if used with sufficient skill and patience, I cannot admit. Doubtless one surgeon will succeed where another fails, but from all that I have seen, either in my own practice or in that of others, I am prepared to fully indorse the statement of Prof. Bumstead, that no surgeon of any considerable experience can honestly maintain that he has never seen an "impassable stricture." Liston and Syme, who were the great advocates of the doctrine that no stricture was impermeable, were both foiled in their later years in

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[1] *Obliteration of the urethra* may result from severe laceration of the part, the urine all flowing through a fistulous opening in the perineum; but such a condition is not, properly speaking, a *stricture*.

the attempt to pass an instrument, and even Sir Henry Thompson, who, in his clinical lectures, published in 1868, declared of the "operation for impermeable stricture" (perineal section), that he had never had occasion to perform it, and doubted if the necessity for it ever existed—in the third edition of the same work (1873) acknowledges that the general rule of permeability admits of a few exceptions, and confesses that he has *thrice* had occasion to perform the operation in question.

3. *Classification according to Symptoms.*—Strictures are further classified according to their symptoms, into the *simple stricture*, the *irritable stricture*, and the *contractile or recurrent* stricture. The significance of these terms will appear in the sequel.

Symptoms of Stricture.—One of the earliest symptoms of stricture, in many cases, is the presence of a slight gleety discharge; there is, besides, pain in micturition, referred to the part of the urethra behind the stricture, and the calls to empty the bladder recur with increased frequency. The stream is diminished in size, and often altered in form, being curiously forked or divided. As a consequence of the small size of the stream, a longer time is required to empty the bladder, and the involuntary straining which attends the act often leads to great irritation of the rectum, with perhaps piles or prolapsus, and, in extreme cases, a discharge of the rectal contents whenever urination is attempted. Retention of urine may occur at any moment from spasm or congestion, or from the occlusion of the narrow passage by a pellet of mucus or a calculous concretion, but more usually the stream gradually lessens until the urine escapes in drops, the bladder slowly becoming distended, until the condition described as *retention with overflow* is established. The retained urine undergoes decomposition, becoming ammoniacal, and producing cystitis with deposit of phosphatic matter. Hæmaturia is an occasional symptom of stricture, the blood being usually of urethral, but sometimes of vesical origin. Ulceration of the bladder, or of the urethra behind the point of stricture, not unfrequently takes place, and, under these circumstances, rupture of the part may result from the straining efforts of the patient, leading to peritonitis or urinary extravasation. In other cases the ureters and pelves of the kidneys become dilated, and chronic renal disease[1] supervenes. Abscesses often occur in the perineum, and more rarely in connection with the anterior portions of the urethra, leading to the formation of urinary fistulæ.

There is, usually, not much *constitutional disturbance* in the early stages of stricture; cases are, however, occasionally met with, in which grave nervous symptoms, with general depression, follow upon very trivial causes—such as the passage of a catheter, slight exposure to cold, etc. These symptoms which are grouped together under the name of *urethral fever*, are chiefly, but not exclusively, met with in cases of *irritable stricture*, so called, in which catheterization produces great and persisting pain. In the advanced stages of stricture, the constitution always suffers, the digestion being impaired, and the patient becoming emaciated and feeble. When the kidneys are seriously affected, convulsions or coma may ensue.

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[1] The peculiar form of renal disease which is so often met with in cases of stricture and other obstructive diseases of the urinary organs as to have been called "surgical kidney," is described by Dr. Dickinson as *disseminated suppuration* of the kidney, a condition closely resembling the renal manifestation of general pyæmia. He proposes the name *uriseptic* as applicable to this form of renal suppuration, believing that it results from the absorption of ammoniacal and putrid urine. Dr. Goodhart is disposed to look upon the surgical kidney as, in some instances at least, an erysipelatous affection.

Urethral Fever is a not infrequent sequel of operations on the urethra and may even occur after the simple introduction of a catheter. This affection is said by Thompson to be most common among the inhabitants of warm climates. It is characterized by the occurrence of rigors (occasionally attended by syncope), with headache and vomiting, followed by febrile reaction. The symptoms, which sometimes return periodically, like the paroxysms of intermittent fever, may immediately follow the introduction of the catheter, but are usually delayed until after the first subsequent act of micturition, and thus appear to be due to the contact of urine with the tender, and perhaps abraded, surface of the urethra. The affection rarely causes death, though it may do so, particularly in cases complicated by the existence of renal disease, possibly, as suggested by Thompson, from the sudden arrest of the function of the kidney. Urethral fever is occasionally followed by inflammation and suppuration of the joints, or of the muscular or areolar tissues, and, indeed, is in many respects analogous to *gonorrhœal rheumatism.* It is, I believe, like that affection, a mild form of *pyæmia.* (See page 441.) It is maintained by Sédillot, Beltz, and other writers, that the occurrence of urethral fever is due to the *absorption of urine*, but this is at least not proved, while the fact that (1) the affection may and does occur in cases in which there is not the slightest reason to believe that any laceration of the urethra exists, and that (2), on the other hand, it does not occur in cases of urinary extravasation or infiltration (as after lithotomy), would seem to justify a contrary opinion.

The *treatment* of urethral fever consists in the administration of nutritious food and stimulants, with tonics, especially quinia and opium. The patient should be kept in bed, and great caution should be exercised in the employment of instruments. As a prophylactic, in patients predisposed to attacks of urethral or (as Holt calls it) stricture fever, quinia and opium may be given at regular intervals after each introduction of the catheter.

Diagnosis of Stricture.—This is made by exploration with a sound or catheter, and may be aided in some cases by the use of the endoscope. When the existence of stricture is suspected, the surgeon should introduce a medium-sized catheter—No. 13 or 14 of the French scale—and if, on several trials, the instrument is invariably arrested at the same point in the membranous or spongy portion of the urethra, the fact that there is a stricture may be considered as established. It is important, in this exploration, to use a catheter of sufficient size, for a small one may lead to error on the one hand, by catching in a lacuna, or, on the other, by passing readily through the stricture, if this be not very tight. To ascertain the degree of contraction which exists, the surgeon may desire the patient to make water, when the size of the stream will afford some information upon this point. It often happens, however, that the patient is unable, from a nervous feeling, to urinate when asked to do so, and the surgeon must then try in succession smaller and smaller catheters, until one is found which enters the constricted part of the urethra. In seeking for the mouth of the stricture, it is well to have some regular course of proceeding; the catheter is not to be thrust blindly in various directions, but should be first carried along the roof of the urethra, and in the median line, then to either side, and finally along the floor of the canal.[1] By means of the *bougie à boule*, the surgeon can ascertain, not only the position and tightness of the stricture, but its extent as well. Formerly wax bougies were employed, with the notion that, by pressing the instrument against the stricture, a mould might be obtained that would show its form and direction; but this mode of exploration has not proved very satisfactory, and is rarely employed at the present day.

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[1] Dr. Stuart Eldridge has devised an ingenious instrument for use in these cases, and has called it the "pathfinder."

TREATMENT OF STRICTURE.

The *Constitutional Treatment* of stricture should never be neglected. The diet should be regulated, and the digestive functions brought into a good condition, Cystitis, if present, should be treated in the way already described, and the general health maintained by the administration of tonics, and by attention to the hygienic state of the patient. Rest in bed for a few days is often a valuable preliminary to instrumental treatment, by relieving the congestion of the parts, and diminishing the tendency to spasm. H. Lee believes that many strictures are of syphilitic origin, and for such recommends the administration of mercury. The *Local Treatment* embraces the application of various methods, which may be classified under the five heads of dilatation, rupture, the use of caustics, and internal and external incision. The use of *caustics* in the treatment of stricture is rarely resorted to at the present day, having been properly superseded by other and safer methods. The articles which have been chiefly employed are the nitrate of silver and the potassa fusa, the cauterizing agent being applied by means of an instrument resembling a catheter with a cup-like depression at its beak, or being simply fixed on the end of a wax bougie. Amussat has recently advocated a modification of this mode of treatment, consisting in the employment of the galvanic cautery applied to the strictured part by means of suitable electrodes.

I shall consider the treatment of stricture under the heads of *permeable stricture, impermeable stricture,* and *stricture complicated with retention of urine.*

I. TREATMENT OF PERMEABLE STRICTURE.

This may be conducted by means of—1, gradual dilatation; 2, continuous dilatation; 3, rapid dilatation, or rupture; 4, internal urethrotomy; and 5, external perineal urethrotomy with a guide (Syme's operation).

1. Gradual Dilatation is by far the best mode of treatment in any instance in which it is applicable, and should be given a fair trial in every case of permeable stricture. An instrument (usually a flexible one) of sufficient size to enter and be fairly grasped by the stricture, should be employed without using such force as to cause pain or lead to hemorrhage; such an instrument having been carried through the stricture and passed into the bladder, may be allowed to remain for a few seconds, when it should be gently withdrawn.[1] After a few days, it may be passed again and followed by a larger instrument, this process being continued until the urethra has, in the course of a fortnight or so, been dilated sufficiently to receive a No. 20 or 22 French catheter, which will be found, in ordinary cases, as large as the canal can accommodate.[2] The dilatation must be subsequently maintained by the introduction of the catheter at gradually lengthening intervals. The mode in which gradual dilatation effects the cure of a stricture, is probably by inducing absorption of the imperfectly organized lymph which infiltrates the submucous tissue. This plan of treatment will be found satisfactory in the majority of cases of gonorrhœal stricture. The great requisites for success are gentle manipulation and patience: no violence is to be used, lest a false passage be made; but the instrument is to be gently engaged in the mouth of the stricture, and held there with the slightest pressure for a few minutes, when it will ordinarily slip through; if not, it should be withdrawn, and a smaller one substituted. The dilatation must also be very gradual; if a No. 10 has been passed at one visit, it will be quite sufficient to get in a No. 11 or 12 at the next, and no advantage can be derived from attempting to progress more rapidly; for, by so doing, an attack of urethral fever may not improbably be induced, which, besides endangering the patient's life, necessitates an abandonment for the time of all treatment for the relief of the stricture.

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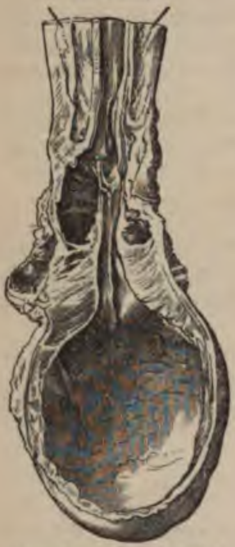
[1] Bardinet recommends that the instrument should be constantly moved backwards and forwards so as to effect an "internal *massage*" of the stricture—a mode of treatment which I cannot approve.

[2] Dr. Otis, of New York, and some other surgeons, believe that the dilatation of the urethra should be carried to a much greater extent, and Dr. Otis has devised an ingenious *urethrometer* for determining what he considers the normal calibre of the tube; I hope that I may not be considered as hopelessly wedded to conservatism, when I express the opinion that a stricture-patient who can pass a No. 21 or 22 catheter without suffering had better rest and be thankful.

False Passages result from the employment of too much force, particularly in the use of small metallic instruments; the usual situation of false passages is at the lower part of the urethra, and to one or other side. At the moment of the instrument's deviating from the proper channel, the patient feels a sharp pain, and is usually conscious of something having given way; the surgeon at the same time perceives that the instrument has slipped from the urethra, by the grating sensation which is produced; and upon placing the finger in the rectum, probably feels the instrument in close proximity to the intestinal wall; if a catheter has been used, blood is pumped through it at every motion, and, whatever instrument has been employed, rather profuse hemorrhage may follow its withdrawal. Should the surgeon be so unfortunate as to make a false passage, he should, if possible, introduce a catheter into the bladder, by keeping its point closely to the roof of the urethra, leaving it in place for a few days, until the laceration has had time to heal. Even if this cannot be done, there is, however, not much risk of urinary extravasation occurring, doubtless on account of the false passage running in the opposite direction to that of the outflowing stream. Old false passages often give a great deal of trouble in the treatment of strictures by dilatation, the catheter tending constantly to slip into the wrong channel. This may be obviated by using a well-curved instrument, and by keeping its point away from the orifice of the false passage, the position of which is soon ascertained; assistance may be also derived by tilting up the beak of the instrument by pressure with the finger introduced into the rectum.

FIG. 520.



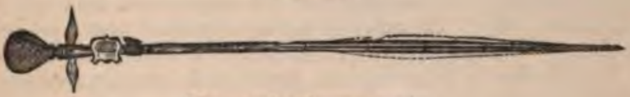
False passages. (DRUITT.)

2. Continuous Dilatation.—This requires the confinement of the patient to bed; it is effected by introducing a catheter, which is then secured in the bladder, and replaced in the course of a couple of days by a larger one, and so on until sufficient dilatation has been accomplished. This is an efficient mode of treatment for cases in which catheterization gives great pain (*irritable strictures*), or in which the stricture manifests a tendency to recontract after ordinary dilatation (*contractile or recurrent strictures*). It may also be properly employed when, from the existence of false passages or other circumstances, special difficulty has been experienced in the first introduction of the instrument. In the employment of continuous dilatation flexible catheters are invariably to be preferred. Under the name of the "multiple-wedge treatment," Dr. J. S. Coleman, of Augusta, Georgia, recommends the introduction of several small bougies, side by side, as an efficient means of practising continuous dilatation.

3. Rapid Dilatation or Rupture.—The methods which are included under these heads may be properly classed together, as the difference in their mode of action is one of degree rather than of kind. Desault, Buchanan, Hutton, Maisonneuve, and Wakley, endeavored to effect rapid dilatation of urethral strictures by introducing first a narrow sound or catheter as a guide, and then sliding over it tubes of gradually increasing sizes. Wakley's instrument, which is probably the best of this kind, consists of a small silver catheter which is first introduced into the bladder, a steel rod being then screwed into its outer extremity, so as to form an unerring guide over which the dilating tubes of gum-elastic or silver are subsequently passed. Fluid pressure,[1] effected with a dilator constructed of silk and catgut, and capable of distension by means of a syringe, was long ago employed by Arnott, and has been more recently resorted to by Steurer, of New York, while the expanding properties of the laminaria digitata have been utilized by Reeves, Newman, and others; but, upon the whole, the best means of effecting rapid dilatation is by using instruments consisting of two or more blades, which can be made to diverge when in the urethra by a screw arrangement in the handle, or by introducing between them plungers, which act on the principle of the wedge. Luxmoor (in 1812), Civiale, Leroy d'Étiolles, Perrève, Lyon, Pancoast, Thebaud, Voillemier, B. Wills Richardson, Schweig, and others, have devised ingenious instruments for carrying out this object, but I shall only describe two, viz., Sir H. Thompson's instrument for "*over-distending*," and Mr. Holt's for "*splitting*" strictures.

Thompson's instrument consists of two blades, which are joined at either end, and which can be separated at an intermediate point by turning a screw in the handle; an index serves to show the extent to which expansion has been carried, the figures corresponding to the numbers of the English catheter scale. The distending force is to be applied rather slowly, so as to overstretch rather than rupture the morbid tissues, and when the instrument is withdrawn, a full-sized gum catheter is passed, and allowed to remain twenty-four hours. Dilatation is subsequently maintained by the occasional introduction of a large sound.

FIG. 521.



Thompson's stricture expander.

Holt's instrument (a modification of Perrève's), in its present improved form, consists of two blades joined at their lower extremity, and fixed in a handle containing a screw which can be set so as to limit the amount of expansion. A guiding rod (made hollow so as to serve for a catheter, and furnished with a stylet to keep it free from clots) passes between the blades, and when the instrument is introduced, a dilating tube, or plunger, of the required size, is slipped over the guide and quickly thrust down in such a way as to split or rupture the stricture; the plunger is next rotated upon the guiding rod, to insure separation of the split, when the whole instrument is removed, and the water drawn off with a full-sized catheter; no instrument is left in the bladder in ordinary cases, but a catheter is passed every other day for a week, and afterwards at longer intervals. The patient should go to bed after the operation, and take two grains of quinia with ten minims of laudanum every four hours until six doses have been taken. Mr. Holt believes that by this instrument the submucous tissue is split, but the mucous membrane of the urethra itself uninjured; but that such is not always the case is shown by the fact that the operation is occasionally followed by rather free bleeding. My own experience with Holt's method is limited, but, as far as it goes, is favorable. I regard it as an excellent mode of treatment in cases of dense cartilaginous stricture of the sub-pubic region, as well as in those of the irritable and contractile varieties. It is, however, not free from risk, urethral fever and death having occasionally followed its employment.

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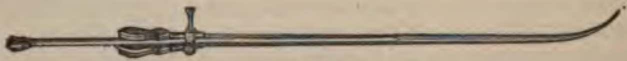
[1] Coze, of Strasbourg, employs fluid pressure, by bringing the weight of a column of water to bear directly upon the face of the stricture by means of an apparatus similar to the ordinary Weber's or Thudichum's douche. A similar plan is employed by Dr. Hadding and Dr. Golding, of New York.

FIG. 522.



Holt's instrument for splitting strictures.

Until within a few years, the application of either of these methods was necessarily delayed until the stricture had been dilated sufficiently to admit the instrument, which could not be made of a smaller size than a No. 8 or 9 French catheter; but it is now possible, by resorting to certain ingenious modern contrivances, to employ the over-distension or rupture treatment at once, for any stricture which is permeable to the smallest filiform bougie. One method, originally suggested, I believe, by Prof. Van Buren, of New York, and widely popularized by Dr. Gouley, of the same city, consists in obliquely perforating the extremity of the instrument which is to be used, so as to make an "eye" by which it can be threaded over a delicate whalebone bougie, previously introduced; while in the other plan, which is attributed by Van Buren to Maisonneuve, and which has been extensively employed by Bumstead, the surgeon makes use of an ordinary filiform gum bougie provided with a metallic cap, which can be screwed on to the extremity of whatever instrument is to be employed; the bougie being introduced, the instrument is attached to its end, and is thus readily guided through the stricture, the bougie itself passing on and becoming coiled up in the bladder.

4. Internal Urethrotomy.—This mode of treatment, which was employed by Allies and Physick in the last century, and by John and Charles Bell in the early part of this century, is particularly applicable to strictures in the anterior part of the urethra, but may also be used for those situated in the sub-pubic region—though for such the treatment by rupture is, I think, preferable. For strictures at or near the external meatus,[1] a probe-pointed bistoury, guided by a small, straight staff or grooved director, will answer every purpose, but for strictures in other localities more complicated instruments are required. These, which are called *urethrotomes*, whatever their exact form (and a great many have been invented by different surgeons), consist essentially in a sound or catheter carrying a concealed blade, which can be made to project by means of a spring in the handle, and which is designed to cut from *before backwards*, from *behind forwards*, or in *both directions*.

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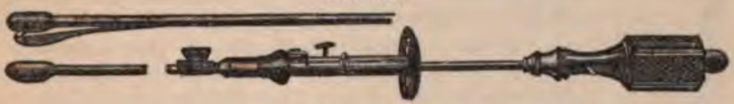
[1] For strictures at the meatus, B. Wills Richardson employs an operation devised many years ago by Colles, of Dublin, and very analogous to that more recently recommended by Weber in cases of congenital occlusion of the part. (See page 950).

Urethrotomy from Behind Forwards, with such an instrument as Civiale's (Fig. 523), is, upon the whole, the safest method, but requires previous dilatation of the stricture, up to the calibre of a No. 8 or 9 French catheter: it is particularly applicable to strictures in the penile portion of the urethra. Civiale's instrument has been ingeniously modified by S. W. Gross, and by Kinloch, of Charleston.

FIG. 523.



Civiale's urethrotome.

Urethrotomy from Before Backwards can only be safely performed by first introducing a guide through the stricture. Many urethrotomes of this kind are now before the profession, including those of Maisonneuve, Wood, Thompson, Trélat, F. N. Otis, Hill, Durham, Teevan, Mastin, Giberson, and Pritchett. These instruments vary in their details, but all act by first securing the introduction of a guide upon which is subsequently passed the blade which divides the stricture. Some combine cutting with dilatation, while others allow the surgeon, if he think proper, to enlarge the incision as the urethrotome is withdrawn.

Whatever method be employed, the incision should, I think, be made on the *lower* and not the upper side of the stricture; a flexible catheter should be kept in the bladder for twenty-four hours, and dilatation subsequently maintained by the occasional passage of a sound. Internal urethrotomy may be performed in the same classes of cases as Holt's operation; but the latter is, I think, to be preferred for strictures behind the scrotum, the former being reserved for those situated anteriorly. In the after-treatment of these cases, Otis employs dry cold applied by Petitgand's method of "mediate irrigation" (p. 55).

5. External Perineal Urethrotomy with a Guide, or the *Operation by External Division or External Incision* (*Syme's Method*), is very commonly confused[1] with the old operation of *perineal section*, which is, however, only applicable to cases of *impermeable* stricture, whereas, a prerequisite for this method (which was introduced by Prof. Syme in 1844),[2] is that a staff shall be passed through the stricture into the bladder. *Syme's staff* varies in size from that of a No. 5 to that of a No. 12 French catheter, and is grooved at the lower third on its convex surface; at the point where the grooved portion joins the rest of the shaft, there is a distinct shoulder, which is made to rest against the face of the stricture, and thus guide the surgeon in his incisions. The operation is thus performed: the patient, being etherized, is secured in the lithotomy position, and the staff introduced (in the case of a very tight stricture, by either of the methods described at page 962);[1] the surgeon then makes an incision about an inch and a half in length[2] exactly in the median line of the perineum, and feeling for the staff, introduces the knife, with its back towards the rectum, into the urethra *behind* the stricture, which is then divided by cutting in the groove of the instrument from behind forwards. A broad grooved director is then slipped into the bladder, and upon this, as a guide, a No. 13 or 14 catheter introduced and secured in the usual way; the instrument is retained for a couple of days, after which a sound must be occasionally passed to prevent recontraction; the perineal wound usually heals without difficulty. Syme subsequently gave up the introduction of a catheter through the urethra, substituting a short perineal tube, so as to afford a free outlet for the contents of the bladder, while Van Buren, Gouley, and other American surgeons, have gone still further and have dispensed with the catheter altogether. The results of this operation are, on the whole, very satisfactory; 219 cases, collected by Thompson, show a mortality of less than 7 per cent., which is a small death-rate in view of the nature of the cases in which it is ordinarily performed.

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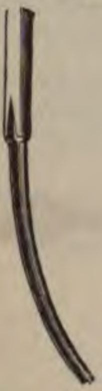
[1] A good deal of this confusion is, I think, owing to the fact that Prof. Syme reported as examples of his own operation, several cases, in which, having failed to introduce his staff, he cut into the perineum, guiding the subsequent course of the instrument by placing his finger in the wound. By so doing he really converted the operations into old-fashioned perineal sections, the only difference being that he cut down upon a small staff instead of a large one, and then slipped the same small staff through the stricture, instead of substituting a grooved director.

[2] A similar procedure had been previously resorted to, and was described by Desault as one variety of the "*boutonnière*," but to Syme is due the credit of making the operation generally known, and of indicating the circumstances under which it should be employed.

FIG. 524.



Syme's staff, for external division of urethral stricture.

The operation by external division is particularly indicated in cases of dense and cartilaginous stricture (particularly when of traumatic origin), and of irritable or contractile stricture, when *complicated by the existence of perineal fistulæ*. In cases, however, in which there is no fistula, Holt's operation is, I think, usually preferable.

Syme's method was also recommended by its distinguished author for the treatment of strictures in the anterior part of the urethra, but for such cases internal urethrotomy seems to me a better method.

II. TREATMENT OF IMPERMEABLE STRICTURE.

Cases are occasionally met with in which, from traumatic causes, the urethral canal is at some part totally obliterated, the urine escaping altogether through a fistula behind the point of injury; beside these cases, there are others which are more properly called strictures, in which, though a few drops of urine make their way through the meatus, yet no instrument—not even a filiform bougie—can be introduced. For such cases Boyer, and afterwards Mayor, recommended *forced catheterization* (a proceeding which was attended with the gravest risks, and is now happily almost entirely abandoned), while Stafford proposed to *cut through* the impassable stricture with a "lancetted catheter." This plan might perhaps be adopted if a stricture in the anterior part of the urethra were so tight as to forbid the safer operation of internal urethrotomy. Such a case must, however, be extremely rare. The application of electricity by means of an electrode pressed against the face of the stricture has been occasionally employed with advantage, and might be tried if the patient objected to more radical measures.

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[1] In order to avoid the entrance of the staff into a false passage, Prof. Gouley proceeds as follows: The urethra being filled with olive oil, an attempt is made to introduce a probe-pointed whalebone guide, the point of which is rendered temporarily spiral by immersing it in boiling water, twisting it around a small staff, and suddenly cooling it. If the point of the guide becomes engaged in a lacuna, it is slightly withdrawn and carried onward with a rotatory movement. If it enters a false passage, it is retained *in situ* with the left hand, while another is passed by its side, this proceeding being repeated until the false passage is filled up, when at last one guide enters the bladder; the others are then withdrawn, and an "eyed catheter staff" threaded over that which is retained, in the way described at page 962.

[2] H. Dick suggested *subcutaneous* division of the stricture, the introduction of the knife being guided by the use of a staff provided with bulbs which could be felt through the tissues of the perineum, and modifications of the subcutaneous method have been recently employed by Mastin, of Mobile, and by Teevan, of London.

There remain to be described the *Operation for Impermeable Stricture, Perineal Section*, or, as it is more accurately called by Prof. Gouley, *External Perineal Urethrotomy without a Guide*, and the operation recently recommended by Mr. Cock. The first is often spoken of as the *boutonnière* or *button-hole incision;* but that name appears, from the writings of Desault, to have been indiscriminately applied by French surgeons to any or all operations which had for their object the establishment of an opening from the perineum into the bladder, and thus would include (beside the ordinary perineal section) the "external division" of Prof. Syme, Cock's operation in which the urethra is opened behind the stricture, and even the now obsolete procedure of puncturing the bladder through the perineum.

1. External Perineal Urethrotomy without a Guide.—The first formal operation of external urethrotomy for the relief of stricture, *unaccompanied by retention*, appears to have been performed about the year 1652,[1] by an English surgeon, named Molins, upon a patient not too respectfully referred to by Wiseman, who gives an account of the case, as "an old fornicator." The urethra had been opened behind the stricture, on account of retention of urine, some time previously, but this not satisfying the patient, Mr. Molins placed him in the lithotomy position, and, giving one testicle in charge to his servant and the other to Wiseman, "with his knife divided the scrotum in the middle, . . . and cutting into the urethra, slit it the whole length to the incision *in perineo*." This rather heroic procedure appears to have been followed by no unpleasant consequences, though it was not successful in curing the perineal fistula. The operation of perineal section was subsequently resorted to by Solingen, in Holland, and by other surgeons, chiefly, however, in cases of retention, but does not appear to have been generally recognized as a legitimate mode of treating stricture unaccompanied by that complication, until the publication of papers by Arnott, in 1823, and Jameson, of Baltimore, in 1824, followed some years later by Mr. Guthrie's well-known work on the "Anatomy and Diseases of the Urinary and Sexual Organs." The latter surgeon recommended that the urethra should be opened *behind* the stricture, which was then to be divided by cutting forwards upon the point of a catheter or sound previously introduced, but most operators have, in all essential particulars, followed the practice of Jameson and Arnott, cutting directly upon the point of the sound, and then cautiously dissecting backwards in the median line. F. Jordan has modified Guthrie's procedure by opening the urethra through the rectum, and then endeavoring to pass a flexible catheter through the stricture from behind forwards, while Callender, Howse, Hulke, and McDougall, following a suggestion of John Hunter's, have similarly attacked the stricture through an opening made into the bladder above the pubis.

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[1] According to Gregory, as quoted by Monod (Étude Clinique sur les Indications de l'Uréthrotomie Externe. Paris, 1880), perineal section was practised by the Italian surgeons in the latter part of the fifteenth century.

External perineal urethrotomy without a guide may be thus performed: The patient being etherized and secured in the lithotomy position, a full-sized catheter, or, which is better, a staff grooved on its convexity, is passed down until its beak rests upon the face of the stricture, taking care that it does not enter a false passage. The staff is then confided to an assistant, who holds it steadily in one position, while the surgeon makes an incision from an inch and a half to two inches in length, exactly in the median line of the perineum. This incision should go through the skin and superficial fascia, and should reach to within about half an inch of the anus. The surgeon next feels for the groove of the staff and cuts into it, thus fairly opening the urethra in front of the stricture. The sides of the canal (the mucous surface of which is easily recognized) are now held apart with tenacula, forceps, or loops of thread—one passed through each margin of the urethra, as advised by Avery—and the part may be still further exposed by turning out the end of the sound through the wound, and thus drawing the urethra forwards, as recently recommended by Wheelhouse, of Leeds. In most instances it will be found possible to slip a small grooved director, a probe, or even a fine whalebone bougie, through the stricture, the mouth of which is thus brought into view; in which case all that remains to be done is to slit up the contracted tissues upon the guide which has been introduced,[1] pass a broad director into the bladder, and upon this a full-sized catheter, which may be left in place for about forty-eight hours.[2] If the opening in the stricture cannot be found, the surgeon must cautiously dissect backwards, with very light touches of the knife, and keeping strictly in the median line, until the dilated portion of the urethra behind the stricture is laid open.[3] This, of course, is the only plan which can be followed in the rare cases, already referred to, of traumatic obliteration of the urethra. The after-treatment consists in the occasional passage of a sound to prevent recontraction. Mastin, of Mobile, after cutting into the healthy urethra in front of the stricture, divides the latter by a subcutaneous incision, and closes the external wound by means of hare-lip pins, so as to, if possible, obtain primary union.

The operation which has been described, is certainly a much more difficult one than that of Prof. Syme, and appears to have been more often followed by death; yet, in view of the otherwise hopeless nature of the cases in which it is performed, it must be considered to give, upon the whole, very satisfactory results. Of 35 cases collected by Boeckel, in which the operation was performed by French or German surgeons, 8 terminated fatally, giving a mortality of nearly 23 per cent.; but in the hands of American surgeons, the results, according to Prof. Gouley, have been much better. Indeed, the operation, if carefully performed, is not in itself very dangerous, and in the majority of fatal cases death has resulted from previously existing disease of the bladder and kidneys. Perineal section, which has, in this country, always been a favorite mode of treating obstinate strictures, is adapted to precisely the same class of cases as Syme's method, except that, to justify the former operation, the stricture must have resisted all attempts to introduce an instrument. The operation is also indicated in some cases of stricture accompanied by retention, in cases of ruptured urethra in which catheterization cannot be accomplished (see page 386), and in some cases of traumatic obliteration of the urethra—though it is a question whether it might not often be better under these circumstances to make no attempt to restore the continuity of the canal, but to simply dilate the fistulous orifice which always exists behind the point of occlusion, or to make a direct opening into the posterior part of the urethra in the way recommended.

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[1] Having secured the entrance of a filiform bougie, Otis passes the other end of the instrument *forwards*, through the *anterior* portion of the urethra, and then screwing on a Maisonneuve's urethrotome, completes the operation by internal section of the stricture at its upper side.

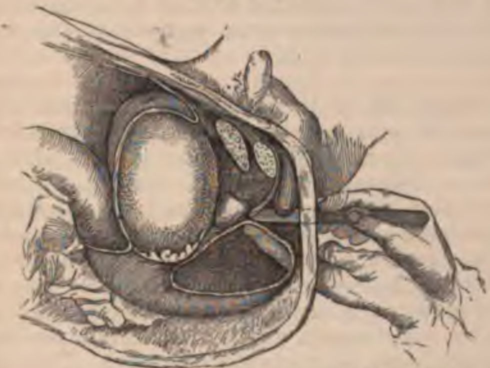
[2] This is considered unnecessary by Van Buren, Gouley, and many other American surgeons.

[3] This seems to me safer than Ruggi's plan of exposing the urethra by a *transverse* incision.

2. Tapping the Urethra at the Apex of the Prostate, unassisted by a Guide Staff, is the name given by Mr. Cock, of Guy's Hospital, to a variety of the old "boutonnière" operation which was frequently practised by Wiseman and others for the *relief of urinary retention*, but which Mr. Cock recommends in cases of impassable stricture, even when not thus complicated. The operation consists in opening the urethra *behind* the stricture, very much in the way it was done by Guthrie, in his mode of performing perineal section; but, whereas Guthrie insisted (and I think with reason) on the propriety of always completing the operation by dividing the stricture itself, Mr. Cock urgently advises that the stricture should not be touched, but that the patient should rather be allowed to recover with a perineal fistula.

The following are Mr. Cock's directions for the performance of this operation: The patient being in the lithotomy position, the left forefinger of the operator is placed in the rectum, with its tip at the apex of the prostate, the relations of which should be carefully ascertained. A double-edged knife is then plunged steadily but boldly into the median line of the perineum, and carried in a direction towards the tip of the left forefinger which lies in the rectum, while, at the same time, by an upward and downward movement, the incision is enlarged in the median line to any extent that is considered desirable. The lower extremity of the wound reaches to within about half an inch of the anus. The knife is pressed steadily onwards towards the apex of the prostate, until its point can be felt in close proximity to the tip of the left forefinger, and is then made to pierce the urethra, by advancing it obliquely either to the right or left. The finger is still kept in the rectum, while the knife is withdrawn, and a probe-pointed di-

FIG. 525.



Tapping the urethra in the perineum. (BRYANT.)

rector introduced through the wound into the urethra, and passed into the bladder. The finger is then withdrawn, and the director held in the left hand, while a canula or female catheter is slid along its groove into the bladder, where it is retained for a few days.

This operation, which I consider a very excellent one, and which I have several times practised with the best results, in cases of *urinary retention* or *urethral rupture*, seems to me inferior to the perineal section (either by Arnott's and Jameson's, or by Guthrie's method), for cases of stricture in which the complication of retention does not exist.

III. Treatment of Stricture Complicated with Retention of Urine.

When permanent narrowing of the urethra exists, a very slight cause may at any moment lead to complete retention (see page 957). Under such circumstances, the sufferings of the patient are very great, and it becomes necessary to adopt prompt and efficient means to evacuate the bladder. The best course to be pursued is, I think, at once to etherize the patient, and, when full relaxation has been obtained, to ascertain the exact locality of the stricture by the introduction of a No. 13 or 14 catheter, and then attempt to pass a small flexible or metallic instrument, trying various sizes in succession, and taking every precaution not to produce laceration of the urethra. If a catheter cannot be passed, perhaps a small bougie may be made to enter the stricture, and it will often happen that when this is withdrawn, after remaining a few minutes, a small stream of urine will follow. The same end may also be attained, in some instances, by pressing for a few minutes with a sound against the face of the stricture. Macnamara, of Dublin, believes that there is in the urethra a vermicular movement towards the bladder, and maintains that if a small catheter can be fixed in a stricture, it will in the course of an hour or so make its own way through the obstruction.

If a filiform bougie can be introduced into the bladder, a catheter can readily be made to follow, in the way described at page 962, when the urine can be drawn off, and the surgeon may at once proceed to treat the stricture by either rupture or internal urethrotomy. Sir Henry Thompson has devised, for use in these cases, a probe-pointed catheter, the beak of which is as slender as the most delicate metallic probe. The instrument is doubtless an efficient one in skilful hands, but seems to me less adapted for general employment than the filiform bougie used in the way which has been described. Dr. F. N. Otis employs a probe-pointed "dilating catheter," with a "testing syringe," which by withdrawing a small quantity of urine shows conclusively when the instrument has reached the bladder. This catheter may be guided through a very close stricture by threading it over a filiform bougie of extra length.

If, after a patient trial for half an hour or so, no instrument can be introduced, or if prolonged but fruitless attempts at catheterization have been already made by another surgeon, the patient should be placed in a hot bath until faintness is induced, and then put to bed, and wrapped in blankets, with hot fomentations to the pubes and perineum. He should be brought thoroughly under the influence of opium, or, if this drug be for any reason contra-indicated, may take the muriated tincture of iron in the way directed at page 954.

Under this treatment the bladder will, in the large majority of instances, relieve itself in the course of a few hours, but should it not do so, the patient must again be etherized, and the attempt to afford instrumental relief carefully renewed. If the surgeon's efforts are still unsuccessful, more decided measures must be adopted. No precise rule can be given as to the length of time during which delay is justifiable in these cases, nor can the surgeon judge accurately of the degree of vesical distension by the size of the tumor which the bladder forms in the supra-pubic region; for, in cases of long-standing stricture, the organ is often thickened and contracted, and may be dangerously distended by an amount of urine which, under other circumstances, would be insignificant. The dangers of delay are very great, and I believe exceed those entailed by a skilfully performed operation. Apart from the risk of rupture of the bladder or urethra, serious injury cannot but be inflicted upon the ureters and kidneys, by the damming up, even for a few hours, of the urinary secretion.

The operations which may be employed for the relief of retention dependent upon organic stricture, are forced catheterization, perineal section, tapping the urethra behind the stricture (Cock's method), and tapping the bladder—through the rectum, above the pubis, or through the pubic symphysis. The first method (forced catheterization) is now, happily, seldom resorted to; it is very uncertain, and extremely dangerous—and should, in my judgment, be utterly banished from practice. The operative procedures employed in all the other methods mentioned have already been described, and it only remains to indicate the particular cases which call for one mode of treatment rather than for another. If swelling or other signs of inflammation in the perineum lead the surgeon to suppose that ulceration or rupture of the urethra may have already occurred, and that urinary extravasation is therefore imminent, if, indeed, it has not actually taken place, one or other of the perineal operations should be preferred, and the choice between these should, I think, rest upon the origin of the stricture, whether gonorrhœal or traumatic. For the former, Cock's operation may be resorted to, as being easier, and, under these circumstances, quite as satisfactory as the perineal section; for, by diverting the course of the urine for a short time, the stricture will, in all probability, become quite amenable to dilatation, or to one of the other methods used in the treatment of permeable stricture. If, however, the stricture be of traumatic origin, it is, I think, better to perform perineal section; for this form of the disease is always very intractable, and it is, therefore, better to employ a radical remedy at the outset.

If, on the contrary, there be no reason to fear urinary extravasation, it is, I think, better, in most instances, to employ the aspirator above the pubis, or, if this instrument be not at hand, to resort to puncture of the bladder through the rectum—which is usually, in these cases, an easy and safe operation; after a few days, the stricture can be dealt with by either dilatation, rupture, internal urethrotomy, or external division, as may be thought proper. If, from the size of the prostate or the contracted state of the bladder, the rectal puncture should be considered undesirable, the next best course would be to open the urethra behind the seat of stricture; or, if the disease were of traumatic origin, the perineal section might be preferred, for the reasons already mentioned.

Ruptures of the Bladder and Urethra are among the gravest sequelæ of retention of urine from organic stricture. *Rupture of the Bladder* (which is very rare) may give rise to peritonitis, or, if the rent be at a part uncovered by the peritoneum, to extravasation of urine within the pelvis; in either case the accident is usually, though not invariably, followed by death, three out of eight cases referred to by Gouley being reported as recoveries. *Rupture of the Urethra* almost invariably occurs at the membranous part of the canal, the urine which is extravasated then making its way into the tissues of the perineum, scrotum, groin, and anterior abdominal parietes, and more rarely passing backwards into the tissues of the ischio-rectal fossæ and buttocks. The *treatment* of these accidents has already been described at pages 384 and 386.

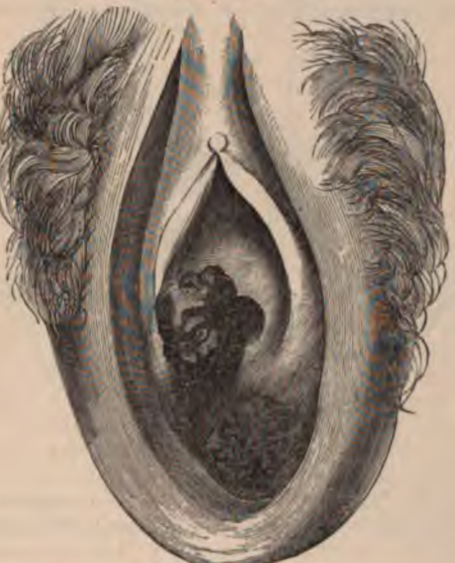
Stricture of the Female Urethra is a very rare affection. It may result from gonorrhœa, or from the cicatrization of a chancre or chancroid, but is more apt to be caused by the inflammation following traumatic injuries, particularly from the use of forceps, or the pressure of the fœtal head in childbirth. The seat of the stricture is usually at or very near the meatus. The treatment consists in dilatation, aided, if necessary, by a slight incision with a probe-pointed knife. In a case of stricture of the female urethra, complicated with retention, in which catheterization proved impossible, Curling resorted to puncture of the bladder through the vagina. Dr. R. Newman reports several cases cured by the use of electricity.

Introduction of the Female Catheter.—The female catheter is shorter and less curved than the instrument used for the male urethra, and should be provided with rings, at its open extremity, to prevent the possibility of its slipping into the bladder. The catheter should be introduced without any exposure of the person, and this may be most conveniently done while the patient is in bed, with the thighs flexed and somewhat separated from each other. The surgeon stands on the patient's left side, and passing his left hand beneath the flexed limb, introduces his forefinger between the nymphæ, bringing it from behind forwards until it touches the space between the entrance of the vagina and the orifice of the urethra, the prominence of which is easily recognized by the touch; the catheter is then introduced with the right hand *above* the flexed limb, and, guided upon the left forefinger, slips without difficulty into the bladder. The whole operation is done under the cover of the bedclothes. In cases of malformation or obstruction, the introduction of the catheter may prove more difficult, and may even be impracticable without the exposure of the part; should retention occur under such circumstances, no false sense of modesty should prevent the adoption of whatever course may be necessary for the patient's relief.

TUMORS AND FISSURE OF THE URETHRA.

The older writers attributed most cases of urinary obstruction to the existence of tumors of the urethra, which they called *caruncles* or *carnosities;* but in the light of modern pathology, true tumors of this part must be considered very rare. In many instances, what have been called tumors, are merely clusters of prominent vascular granulations, which, as in other mucous membranes, occasionally result from long-continued inflammation. True urethral tumors are, however, occasionally met with, belonging chiefly to the *papillary* and *fibro-cellular* varieties. The papillary growths are principally seen near the meatus, and are much less common in the male than in the female sex, while the fibro-cellular or polypoid tumors are chiefly limited to the prostatic part of the male urethra. *Tuberculous* and *cancerous* deposits, also, are occasionally seen in the urethra; but are usually secondary to similar formations in the kidney, bladder, or prostate. The *treatment* of the vascular papillary growths which are seen near the meatus, and which alone are likely to be recognized during life, consists in excision, ligation, the application of caustics (of which the best, according to Dr. Edis, are chromic and carbolic acids), or the use of the actual or galvanic cautery. The latter is the safest remedy for the vascular tumors of the female urethra, excision being, in this locality, attended with some risk of hemorrhage. If the hot iron is used, the surrounding parts should be protected with a wooden spatula. Should spasmodic contraction of the urethra persist after removal of the growth, forcible dilatation (as recommended by Richet) may be resorted to, and the same plan may be adopted, as advised by Spiegelberg, in the treatment of *fissure* of the female urethra, a condition analogous to the fissure, or painful ulcer, of the rectum (see pages 851, 932). According to Skene, many of the so-called caruncles, or vascular growths, observed near the meatus of the female urethra, are really instances of an inflammatory condition of certain glands found in that part, to be treated by caustic applications, or by slitting open the ducts of the glands as in fistula in ano.

FIG. 526.



Papillary tumor of the female urethra. (BOIVIN.)

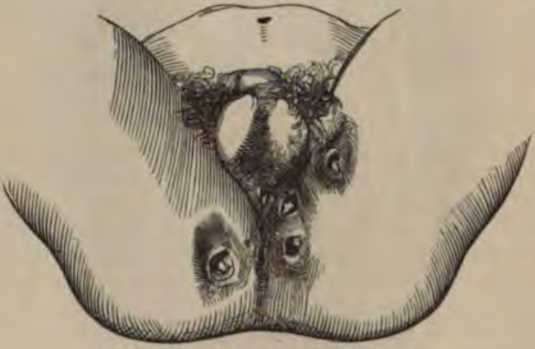
URINARY FISTULA IN THE MALE.

Urethral Fistula.—Fistulous communications between the male urethra and the external surface of the body are not unfrequently met with in cases of long-standing stricture. There may be one or several external openings, and these may be situated in the perineum, scrotum, or lower surface of the penis, or even in the thighs, buttocks, or abdominal wall.

The *treatment* must be directed in the first place to the cure of the stricture, for the abnormal openings cannot be expected to heal while any obstruction to the natural course of the urine remains. Simple dilatation will in many cases be sufficient, and it often happens that, when the normal calibre of the urethra has been restored, the fistula will heal of itself. If the stricture is very hard and cartilaginous, or peculiarly irritable, or if, though easily dilated, it constantly tends to recontract, it will usually be advisable to resort at once to external division (Syme's method), which promises better results under these circumstances than either rupture or internal urethrotomy.

If the stricture be impermeable, the perineal section must be performed as a last resort. If the fistula still persist after the cure of the stricture, special means must be adopted for its treatment. It is often recommended to retain a catheter in the bladder, in these cases, so as to prevent any urine from escaping through the fistula; but the plan very seldom succeeds, for the reason that a small quantity of urine invariably trickles alongside of the instrument, and thus defeats the object in view.[1] It is much better to teach the patient to use a gum-elastic catheter for himself, when, if he can be induced to co-operate with the surgeon by not, under any circumstances, urinating except through the instrument, the fistula will probably heal without difficulty under simple dressing. The *special treatment* of urethral fistulæ varies according as they are seated in the perineal, scrotal, or penile portions of the urethra.

FIG. 527.



Urinary fistulæ in the male. (LISTON.)

1. **Perineal Fistula.**—If of small size, a perineal fistula may be induced to heal by introducing a fine probe coated with nitrate of silver, or (which is probably the most efficient means) by the application of the galvanic cautery. If there be several external openings, a good plan is to connect them together with an oakum thread, introduced by means of an eyed probe; while, if this fail, it may be necessary to lay open the smaller sinuses by incision upon a grooved director. If the fistula be a large one, its edges may be touched with strong nitric acid, so as to make a superficial slough, which, when detached, will leave healthy granulating surfaces; or the edges may be deeply pared, and brought together with metallic sutures. Voillemier and Guyon recommend that the fistula and surrounding tissue should be cut out by means of curved incisions meeting in front and behind.

2. **Scrotal Fistula,** on account of the lax condition of the parts, usually requires to be freely laid open, when it will probably heal by granulation; or the edges may be deeply pared and the adjacent tissues dissected up, so as to form broad and thick flaps, which are then to be accurately brought together in the median line with deep and superficial sutures.

3. **Penile Fistula** is the most intractable form of urethral fistula, and can seldom be cured without a plastic operation. In some cases, however, suc-

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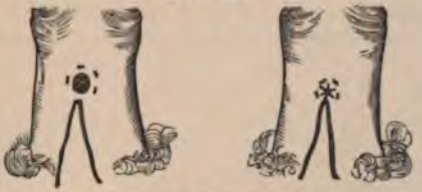
[1] Chiene employs a catheter with an India-rubber tube attached, passing into a bottle placed on the floor; a siphon action is thus established, and the bladder kept empty by drainage.

cess may be obtained by touching the edges with nitric acid, and holding the granulating surfaces together with *serre-fines*, after the detachment of the slough. The contact of urine must be prevented by keeping a full-sized catheter in the bladder, or, which is usually better, by the frequent introduction of a flexible instrument. *Dieffenbach's lace-suture* may also be applied with advantage in some cases. The edges of the fistula are first blistered with the tincture of cantharides, and the cuticle scraped off with a scalpel. By repeated introductions of a small curved needle, a waxed silk thread is next carried subcutaneously around, but not across, the fistula, at a distance of about a quarter of an inch from its margin, when, by drawing upon both ends of the thread, the opening is puckered up like the mouth of a purse, and secured with a knot. The suture may be removed after three or four days. E. Noble Smith has recently reported a case in which a cure was effected by the application of a strong solution of nitrate of silver (ʒj–f℥j) to the *urethral* as well as to the external orifice of the fistula.

FIG. 528.



Dieffenbach's lace-suture.

4. **Blind Urinary Fistula** is the name given to suppurating tracks opening into the urethra, but having no external orifice. The *treatment* consists in laying open the sinus, and then proceeding as in the case of an ordinary urethral fistula. A similar affection is described by Skene, of Brooklyn, as occurring in women, and as curable by dilating the canal and using astringent injections.

Urethroplasty.—The simple urethroplastic operations occasionally required in cases of perineal and scrotal fistula, have just been mentioned. More complicated procedures are, however, often needed in the treatment of fistulæ in the penile portion of the urethra.

1. A good plan is to freshen the edges of the fistula, and dissect up long, bridge-like flaps, which are then stitched together over a slip of India-rubber, or, which is better, a piece of thin lead ribbon (Fig. 529), so as to prevent the contact of urine. This operation is said to have originated with Dieffenbach.

2. Alliot, Ségalas, Nélaton, and others, have succeeded in curing penile fistulæ by dissecting up the integuments around the opening and sliding them over the latter, after freshening its edges.

3. Astley Cooper operated by paring the edges of the fistula, so as to form a quadrilateral wound, which was then closed with a flap of similar form, borrowed from the scrotum.

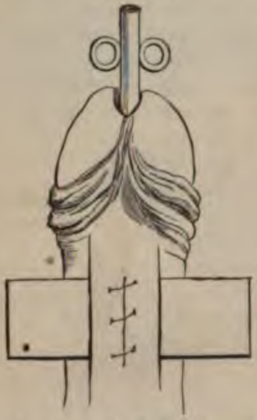
4. Le Gros Clark pares the edges of the fistula, and closes it by dissecting up flaps from each side and joining them in the middle line by means of the clamp or quilled suture. Somewhat similar operations are attributed to Reybard and Delorne.

5. R. F. Weir, following Langenbeck and Szymanowski, has succeeded

by inverting an oval flap from one side of the fistula, and pocketing it in a groove upon the other side.

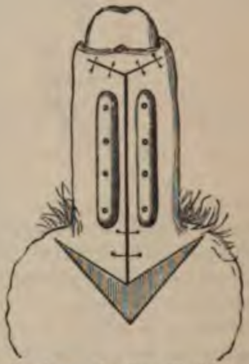
Whatever plan be adopted, it may, perhaps, be thought advisable to divert the course of the urine for a few days, by puncturing the bladder through the rectum, or, better, by opening the urethra in the perineum, as has been done by Ségalas, Ricord, and Thompson. The results of all these operations are apt to be disappointing; 82 cases tabulated by Czerny gave in all but 35 recoveries, and in many of these the duration of treatment was more than a year.

FIG. 529.



Urethroplasty; Dieffenbach's method. (ERICHSEN.)

FIG. 530.



Urethroplasty; Le Gros Clark's method. (ERICHSEN.)

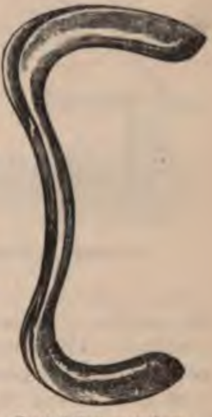
Urachal Fistula.—It occasionally happens that the urachus remains patulous and allows a discharge of urine from the umbilicus. This rare condition, of which I have seen but two examples, has been effectually remedied by Guéniot by the application of ligatures and caustic so as to occlude the umbilical opening. Jacoby has effected a cure by the use of the actual cautery, and A. Rose, of New York, by means of a plastic operation. Worster has in the same way cured a case of urachal fistula opening between the umbilicus and pubes. The ligature and cautery combined proved effectual in a case sent to my *clinique* by Dr. Marcy, of Riverton, N. J. If the fistula be complicated by the existence of phimosis, this should be relieved first, when the urachal opening may close of itself, as in a case recorded by Charles.

Vesico-rectal and Urethro-rectal Fistulæ have already been considered (see page 847).

URINARY FISTULA IN THE FEMALE.

Of this there are five varieties, the *urethro-vaginal*, the *vesico-vaginal*, the *vesico-utero-vaginal*, the *uretero-vaginal*, and the *vesico-uterine fistula*. The locality of the fistula in each case is indicated by the name. The *causes* of these fistulæ are direct injury, abscess, ulceration, and sloughing due to pressure, as from the child's head in labor—the latter being by far the most frequent origin of the affection. The *consequences* of this condition are extremely annoying to the patient; incontinence of urine is almost constantly present, leading to excoriation of the genital organs and thighs, and giving rise to an ammoniacal odor which renders the patient an object of loathing to herself, if not to all around her. The *diagnosis* can be made by placing the patient on her elbows and knees, and exposing the part by drawing away the opposite wall of the vagina with a Sims's or Bozeman's duck-billed speculum (Fig. 531); if the fistula be very small, it may elude detection unless the bladder is injected, which may be done with simple water, milk, or a weak infusion of madder or indigo.

FIG. 531.



Duck-billed speculum.

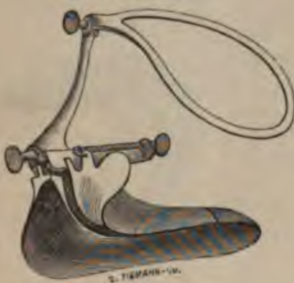
The consideration of the *treatment* of the vesico-vaginal and other varieties of urinary fistula met with in the female sex, belongs rather to the department of Gynæcology than to that of General Surgery, and I shall, therefore, content myself with indicating the principles upon which the various modern operations for the relief of these affections are founded, referring the reader for more detailed information to the excellent works of Simpson, Sims, Brown, Emmet, Byford, Thomas, Agnew, Goodell, and other writers on these subjects. Until within a few years, these affections were generally considered incurable, and it is chiefly through the labors of American surgeons that the operative treatment of vaginal fistulæ, from being the opprobrium of our art, has been made one of the most successful procedures in the whole range of surgical practice. Without wishing to make invidious distinctions, I may refer particularly to the early labors of Hayward, of Massachusetts, and Mettauer, of Virginia, and to the brilliant successes more recently obtained by Marion Sims, who, in 1852, as justly remarked by Thomas, combined the essentials of success, and placed the operation at the disposal of the profession. Since this time the subject has been illustrated both at home and abroad, by Bozeman, Emmet, Schuppert, Briggs, Agnew, Simpson, Brown, Bryant, Wells, Kidd, Simon, Ulrich, Neugebauer, and many other surgeons.

If a urethro-vaginal or vesico-vaginal fistula be very small, an attempt may be made to effect its closure by the application of the actual or galvanic cautery, or by touching the edges with nitric acid and holding them together with *serre-fines*, a plan which has been recently recommended in some cases by Spencer Wells. The large majority of fistulæ, however, require an operation, which essentially consists in paring the edges of the opening, and approximating the raw surfaces (preferably in a transverse direction) by means of sutures, which are left in place until firm union has occurred. This plan is more generally applicable than any of the flap operations which have been suggested, though these may be occasionally useful in particular cases.

Operations for Urinary Vaginal Fistulæ.—The points which require special consideration are—1. The position of the patient; 2. The mode of exposing the fistula; 3. Paring the edges; 4. Introduction of the sutures; 5. Fastening the sutures; 6. Use of the catheter during the after-treatment; and 7. The time at which the sutures should be removed. The patient should be prepared for the operation by attending to the state of the general health, by subduing local inflammation, and by dividing any cicatricial bands that might interfere with the success of the treatment. A dose of castor oil should be administered the night before, and an enema given on the morning of the operation, while to avoid the suffering, both physical and mental, to which this would otherwise necessarily give rise, the patient should invariably be anæsthetized, unless there be some special reason to the contrary.

1. Position of the Patient.—The best is, I think, a modification of that known as the knee-elbow position, the patient being supported upon pillows or on a well-padded double-inclined plane, with the hips elevated, and the head and shoulders depressed, the thighs widely separated, and held apart by assistants; Sims and Emmet, however, prefer a semi-prone position, the patient lying partly on the left side with the thighs flexed —the right rather more than the left—and the breast resting upon the table, while Simon adopts the supine position, with the hips and thighs much raised, and Wells recommends the ordinary lithotomy position, with the hands and feet fastened together with bandages or straps.

FIG. 532.

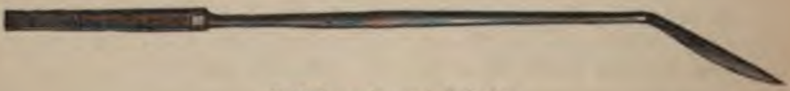


Emmet's speculum.

2. Exposure of the Fistula.—This may be done with an ordinary Sims's speculum, held by an assistant, or by means of Emmet's modification of that instrument, if the semi-prone position is chosen, or by a similar modification described by Wells, if the patient be placed either on her back or in the position here recommended. These modifications of Sims's speculum consist in the adaptation of a fenestrated blade, which fits over the buttock or sacrum of the patient, and thus keeps the instrument in place without the aid of an assistant. A bright light is necessary for the operation, the best illumination being afforded by placing the operating table near a high window; if this cannot be obtained, an Argand lamp and reflector may be substituted.

3. Paring the Edges.—This may be done with either knives or scissors, according to the fancy of the operator; it is convenient to have a double-edged knife curved on the flat, and others with the blades bent at an angle with the shaft (Fig. 533). The sides of the fistula may be steadied by means of suitable forceps, or one or more hooks with long handles, while the paring is effected by transfixing the part with the knife, and cutting first in one, and then in the opposite direction, so that a complete ring is denuded. In doing this, some surgeons cut perpendicularly to the plane of the vesico-vaginal septum, while others bevel the edges by cutting in an oblique direction, so as to spare the mucous membrane of the bladder. Langenbeck again, and, more recently, Collis, of Dublin, have advised that the edges of the fistula should be split, so as to obtain a broad raw surface without cutting away any tissue whatever. Provided that a broad surface be obtained for adhesion, it probably makes little difference which particu-

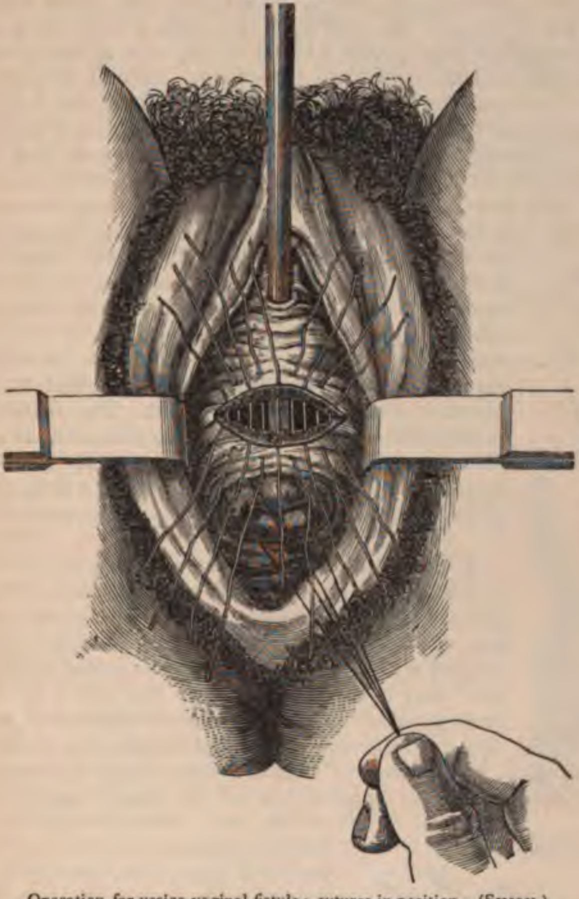
FIG. 533.



Knife for vesico-vaginal fistula.

lar plan is adopted. Before proceeding to the next step of the operation, all bleeding should be checked by torsion, by pressure with a piece of sponge mounted on a handle or "sponge-holder," or by throwing in a stream of cold water with a syringe.

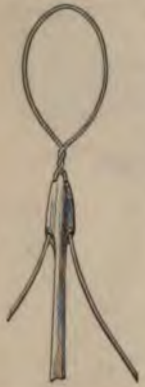
FIG. 534.



Operation for vesico-vaginal fistula; sutures in position. (SIMON.)

4. Introduction of the Sutures.—The material generally chosen for the suture, in this country, is, in accordance with the practice of Sims and Bozeman, silver wire; and this seems to me, upon the whole, preferable to the other substances used for the purpose. Simon, however, employs a silken, and Ulrich, of Vienna, a hempen suture; while Wells considers, and probably with good reason, the choice of material much less important than has been commonly supposed. Wutzer employed the harelip pin and twisted suture, and the same plan with various modifications has been since adopted by Metzler, of Prague, Mastin, of Mobile, and Watson, of Edinburgh. The sutures, whether of silk or metal, may be conveniently introduced with short well-curved needles held by suitable forceps, or with needles eyed near the point, and mounted in handles like the ordinary nævus needle. Sometimes the silk or wire may be threaded upon two needles, each of which is introduced from the vesical surface of the fistula; or an eyed needle, threaded, may be passed through one margin, and a notched needle, unthreaded, through the other—the loop of the thread being then caught in the notch and thus drawn through; or, again, the surgeon may adopt a plan similar to that of Mr. Avery, in the operation for cleft palate (see p. 762). Dr. Joseph Bell employs steel points welded to the wire, so as to leave no projecting shoulder and to require no threading. Special needles have been devised for this operation by Druitt, Startin, and others, but I am not aware that they possess any superiority over the simpler implements above recommended. The passage of the needle from within outwards may be aided by steadying the part to be transfixed with a blunt hook bent at an angle to its shaft, and, when wire is used, advantage may be derived from drawing it over a notched "feeder," which prevents it from cutting through the margin of the fistula. When the edges have been bevelled or split, the sutures should be passed so as not to encroach upon the vesical mucous membrane, but this may be included when the fistula has been pared perpendicularly to the septum. The sutures should be passed about half an inch from the free margin of the fistula, and should be about a sixth of an inch apart. The fistula should, if possible, be closed in a *transverse* direction, so as to form a cicatrix at right angles to the long axis of the vagina. A single set of sutures may be used, or a deep and superficial set, according to the fancy of the operator.

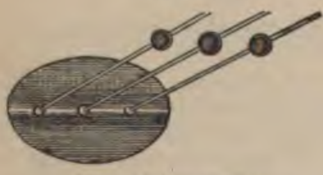
FIG. 535.



Coghill's wire twister.

5. Fastening the Sutures.—If of silk, the sutures are to be tied in an ordinary surgeon's knot, all the knots being made on the same side of the fistula; wire sutures may be conveniently clamped with perforated shot, or twisted with the fingers, or, if the fistula be high up, with the "wire twister" devised by Coghill (Fig. 535); or the ends on either side may be passed through a metalic plate and secured with shot (as in Sims's earlier operations); or Bozeman's ingenious modification, known as the "button suture," may be substituted (Fig. 536); or the surgeon may employ one of the many shields and splints which have been devised by Simpson, Brown, Agnew, and others. In the majority of cases, however, the simple interrupted suture will, I think, be found more satisfactory than any other. As a test of the accurate closure of the fistula, an attempt may be made to pass a probe between the stitches, and the bladder may be injected with milk or colored water.

FIG. 536.



Bozeman's button suture.

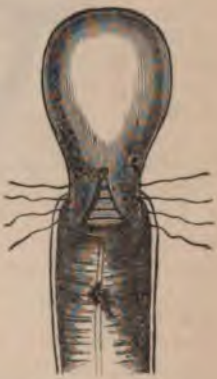
6. The Catheter.—It is by the large majority of writers thought very important to introduce a catheter—Sims's "sigmoid" instrument (Fig. 465) is the best—immediately after the operation, and to keep it in place during the after-treatment. Simon, however, has discarded the catheter altogether, except in cases of retention, when he introduces the instrument at intervals of three or four hours; while Wells introduces at first a small vulcanite catheter, but removes it as soon as it causes any irritation or discomfort. In this country, the principal advocates of the disuse of the catheter are Dr. Schuppert, of New Orleans, and Dr. Briggs, of Nashville. If the catheter be used, great care must be taken not to let it become clogged with mucus.

7. Removal of the Sutures.—This may be done while the patient is in the semi-prone position. Silk sutures should be withdrawn about the 6th or 7th day, and wire sutures from the 8th to the 14th; it is better to retain them unnecessarily than to remove them prematurely.

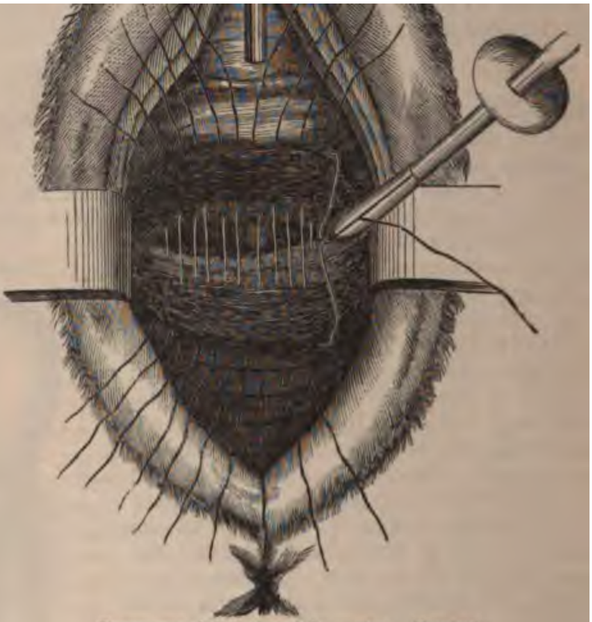
The bowels should be locked up with opium for about two weeks, and cleanliness insured by daily syringing of the vagina. If the urine be ammoniacal, the bladder may be washed out through a double catheter.

Modifications Required in Special Cases.—When the fistula is placed in the upper part of the vesico-vaginal septum, care must be taken not to implicate the ureters in the operation. Neglect of this precaution may lead to failure, from the ureter opening into the vagina above the cicatrix, or even to death, from occlusion of the ureter and consequent uræmia. For *uretero-vaginal* fistulæ, Parvin turns the displaced distal extremity of the ureter into the bladder, and then closes the vaginal opening, while Landau recommends that an attempt should be made to pass a catheter from the bladder through the ureter, the opening in which is then to be closed over the instrument; or, if this cannot be done, that the lower part of the ureter should be slit into the bladder, so as to convert the case into one of ordinary vesico-vaginal fistula. In cases of *vesico-utero-vaginal* fistula, the anterior lip of the uterus, or possibly the posterior lip, must be utilized in closing the opening: in the latter case, the patient is rendered sterile, and the menses escape through the urethra. In cases of *vesico-uterine* fistula, the anterior lip of the uterus must be slit up until the opening is exposed, when its edges may be freshened and united with sutures. In cases of very great deficiency of the vesico-vaginal septum, the operation of *transverse obliteration of the vagina* (Fig. 538), as employed by Simon and Bozeman, may be necessary: this consists in paring the anterior lip of the fistula, and attaching it to the previously denuded posterior wall of the vagina, so as to completely close the orifice of this canal; the menses subsequently escape through the urethra, but the patient is rendered sterile and unfitted for sexual congress. Hence, when applicable, a better plan, also suggested by Bozeman, is to endeavor to lessen the antero-posterior diameter of the fistula, by daily dragging down the neck of the uterus, with forceps, for some weeks prior to the operation, which is then performed as in an ordinary case of vesico-utero-vaginal fistula. When the floor of the urethra is completely destroyed, as well as the vesico-vaginal septum, it may be necessary to pare, or split, and unite the labia, as in the operation of episiorrhaphy (p. 1010), so as to close the vulva, except at its anterior portion, where an opening must be left for the escape of the urine and menses, incontinence being prevented by the adaptation of a suitable truss. This operation, which I have

FIG. 537.



Operation for vesico-uterine fistula. (THOMAS.)



Transverse obliteration of the vagina. (SIMON.)

tube, so as to insure a free exit to the urine until the union c surfaces is complete.[1]

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[1] In the above pages I have drawn freely from the excellent *Treatise on of Women*, by Prof. T. G. Thomas, of New York, and from a valuable treatment of vaginal fistulæ, by Mr. T. Spencer Wells, in *St. Thomas's H* N. S., vol. i., 1870.

CHAPTER XLVII.

DISEASES OF THE GENERATIVE ORGANS.

DISEASES OF THE MALE GENITALS.

MALFORMATIONS OF THE PENIS AND SCROTUM.

Congenital Adhesion.—The penis is sometimes bound down to the scrotum by a web of skin extending from the lower surface of the organ to the raphe; the *treatment* consists in dividing the web, and bringing the edges of the wound together in a longitudinal direction (as successfully done by Bouisson), or if this be impracticable on account of the shortness of the attachments, in carefully dissecting the penis from its abnormal position and raising it towards the belly, the gap in the scrotum being then filled with a flap borrowed from the groin or thigh, as suggested by Holmes.

Incurvation of the Penis (with hypospadias) is occasionally met with, and may seriously interfere with procreation: the *treatment* may consist (1) in division of the contracted tissue, subcutaneously, as practised by Bouisson, or, *à ciel ouvert*, as preferred by Duplay; (2) in excising a wedge-shaped piece from the dorsum of the organ by transverse incisions, and bringing the sides of the wounds together so as to raise the glans penis, as advised by Physick, Pancoast, and Gross; (3) in amputating the head of the organ, and enlarging the hypospadic orifice, as suggested by Holmes, or (4) in *splicing* the contracted part as ingeniously suggested by Dr. Gouley, of New York. Dr. R. F. Weir, also of New York, has, in two cases in which this condition was complicated by congenital adhesion to the scrotum, successfully resorted to a modification of Bouisson's method, while Dr. E. Bradley, of the same city, has operated by making V-shaped incisions on the lower surface of the organ, which was then strapped up against the abdomen while cicatrization occurred.

Fissure, or Cleft of the Scrotum, occurring in connection with malformation of the penis and complete hypospadias, constitutes a variety of so-called hermaphrodism; the cleft scrotum represents the labia majora, and the deformed penis the clitoris, and if the testes be retained within the abdomen the resemblance to the female organs is tolerably complete. These cases seldom admit of operative interference, but the surgeon may be called upon to express an opinion as to the sex of the child, and to advise as to the mode in which it shall be brought up. The diagnosis of sex can usually, but by no means always, be made by simultaneous rectal and vesical exploration; if no trace of a uterus be found, and if the supposed vagina open directly into the bladder, the *probability* is that the subject belongs to the male sex. In a case of doubt, it would probably be judicious, as advised by Holmes, to bring the child up as a boy.

PHIMOSIS.

Phimosis may be either congenital or acquired. This condition consists in an elongation of the prepuce, with contraction of its orifice, preventing the foreskin from being drawn back so as to expose the glans penis.

Congenital Phimosis.—In congenital cases the contraction is most marked in the inner or mucous layer of the prepuce, which adheres more or less closely to the surface of the glans,[1] while the skin of the part is comparatively lax. Phimosis is often the source of great inconvenience, if not of positive disease. In childhood, it may form an impediment to the flow of urine, leading to irritation of the urethra and bladder, and giving rise to symptoms of vesical calculus, and, sometimes, to reflex, nervous phenomena, paralysis, etc. By the straining which it occasions, it sometimes predisposes to hernia. In adult life, it may interfere with the discharge of semen, and thus render the patient practically sterile, while, by preventing the retraction of the prepuce, it causes an accumulation of smegma, producing great irritation of the part, and exposing the patient to repeated attacks of balanoposthitis. Phimosis, moreover, apparently renders its subject more liable to the various forms of venereal infection, and becomes a serious complication when venereal diseases are acquired. It also, in the opinion of Hey, Holmes, and others, predisposes to the development of malignant disease of the part.

Acquired Phimosis may result from thickening of the prepuce, following gonorrhœal or chancroidal inflammation, or may be dependent upon the existence of fissures or excoriations of the part. In some instances, phimosis is complicated with a condition of solid œdema of the prepuce, constituting a state of hypertrophy, which, like the analogous hypertrophy of the clitoris, seems, occasionally, to be due to constitutional syphilis.

Treatment of Phimosis.—In some cases it is sufficient to *divide the mucous layer* of the prepuce, which is, as has been mentioned, the part chiefly affected in congenital phimosis, but in many instances it will be necessary to adopt severer measures, which may be classified under the heads of *incision, excision*, and *circumcision*.

1. Division of the Mucous Layer of the Prepuce may be accomplished in several ways:

(1.) Sudden dilatation or rupture of the mucous layer may be effected by introducing the blades of an ordinary pair of dressing forceps between the prepuce and glans penis, one on either side, and then quickly withdrawing the instrument with its blades widely separated; the foreskin is then drawn back, and kept retracted for about forty-eight hours. This plan is said to have originated with Hutton, of Dublin, and has been, lately, highly commended by Cruise, of the same place, who has devised a special instrument for the operation. A three-bladed forceps is employed for the same purpose by French surgeons.

Erichsen recommends, in cases of acquired phimosis depending upon fissures of the preputial orifice, *gradual dilatation*, effected by means of a two-bladed urethral dilator, such as is used in the operation of lithectasy in the female.

(2.) The surgeon may employ a small pair of scissors, the lower blade of which is probe-pointed, introducing this blade between the prepuce and glans, and thrusting the other or sharp-pointed blade between the layers of the prepuce. The contracted mucous layer can now be divided at a single stroke, the foreskin being then retracted, as in the previous method. This mode of operating appears to have originated with Dr. Edward Peace, of this city, formerly one of the surgeons to the Pennsylvania Hospital.

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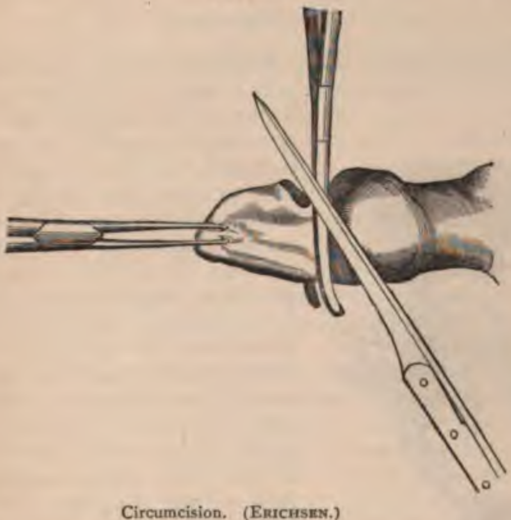
[1] According to Bókai, adhesion of the inner layer of the prepuce to the glans penis is a normal condition during early infancy. It may give rise to many of the symptoms which are ordinarily attributed to true phimosis, but may be distinguished by the readiness with which the foreskin can be drawn back, showing that its orifice is not really contracted.

(3.) Faure's method consists in forcibly drawing backward the skin of the penis, and dividing the mucous layer of the prepuce, which is thus made tense, by a succession of notches with a pair of probe-pointed scissors.

2. Incision.—This may be done either at the upper or lower surface of the penis; probe-pointed scissors may be used, or the surgeon may introduce a grooved director, and upon this a sharp-pointed curved bistoury, which is then made to transfix the prepuce and cut from within outwards, scissors being employed, if necessary, to complete the division of the mucous membrane. Another plan is to dispense with the director, guarding the point of the bistoury with a small piece of wax until it has reached the desired point, when it is made to transfix and cut its way out as before. If the incision be made below, the frænum, if too short, may be at the same time divided. This method is attended with the disadvantage of leaving a wing-like projection of preputial tissue on either side of the penis, constituting an unseemly deformity, and, if, as often happens, the prepuce subsequently becomes thickened and hypertrophied, interfering with coitus.

3. Excision.—The prepuce having been divided with a bistoury along the dorsum of the penis, as in the operation by incision, the flaps on either side may be seized with forceps and cut off in an oblique direction, so as to make an oval wound; the mucous membrane is then attached to the skin with silk or lead sutures, and the part covered with a cold-water dressing. This operation gives a very good result, and is, I think, particularly applicable to those cases in which the prepuce is in a state of solid œdema and hypertrophy. Other plans are to excise the frænum, together with a V-shaped portion of the prepuce, as in the operations of Taxil and Jobert (de Lamballe), or to remove with scissors a semilunar flap, as in the method of Lisfranc.

FIG. 539.



Circumcision. (ERICHSEN.)

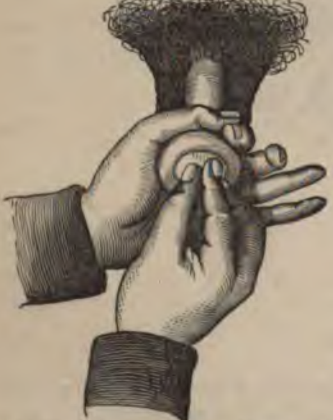
4. **Circumcision** is, I think, ordinarily the best mode of treatment. The prepuce should be drawn forwards, so that the portion which corresponds, in the ordinary condition, to the line of the corona glandis shall be entirely in front of the penis; a pair of narrow-bladed forceps is then applied in an oblique direction (so as not to encroach too much upon the frænum), and firmly held by an assistant, while the surgeon with knife or scissors removes the part of the prepuce which is in front; when the instrument is removed, it will be found that more of the skin has been taken away than of the mucous membrane, and it is, therefore, usually necessary to slit this along the dorsum of the penis—when the corners of the flaps thus formed may be excised, and the operation completed by uniting the skin and mucous membrane with silk or lead sutures, or with *serre-fines*. This operation is commonly attended with some little hemorrhage, which, if sutures are used, can be conveniently checked by transfixing each of the bleeding vessels with one of the stitches; under other circumstances, ligatures may be required. An ingenious modification of this operation is that introduced by Ricord, who has devised for the purpose a pair of *fenestrated forceps*, through which the suture threads may be introduced before the prepuce is cut off; the forceps being removed, the mucous membrane is, if necessary, slit along the dorsum, and each thread divided in the middle, so as to form a suture on either side. Dr. Levis has invented ingenious forceps to facilitate the cutting away of the *mucous layer*, without the *skin*, of the prepuce.

No operation for phimosis should, as a rule, be performed in any case complicated with chancroid, lest the whole wound should become inoculated. In order to prevent the occurrence of painful erections after these operations, Dr. Otis, of New York, recommends the use of dry cold applied by means of Petitgand's method of mediate irrigation (p. 55).

PARAPHIMOSIS.

This is the name given to the condition in which the prepuce has been drawn up above the corona glandis and cannot be replaced. The glans soon becomes swollen and œdematous, from the constriction exercised by the preputial orifice, and, if relief be not afforded, ulceration or sloughing may occur. Paraphimosis is chiefly met with in boys, but may occur at any age if the prepuce be contracted. The *treatment* consists in effecting reduction, which may be sometimes aided by preliminary scarifications, or by the application of the cold douche or of ice. Reduction may usually be accomplished by the surgeon's fingers, combining traction upon the prepuce with compression of the glans, which should be well oiled and covered with a small rag, to prevent the fingers from slipping. The surgeon first compresses the glans firmly for five or ten minutes with the fingers of the right hand, so as to squeeze the blood out of the part, and then encircling the prepuce with the left hand, as shown in Fig. 540, gradually draws the part into its normal place, aiding the manœuvre by trying to insert the right thumb-nail beneath the edge of the preputial orifice. Other

FIG. 540.



Reduction of paraphimosis. (PHILLIPS.)

plans are to compress the glans by surrounding it with a tape or strip of adhesive plaster, or by applying broad-bladed forceps; or to raise the preputial ring upon a director, while the glans is pushed up beneath the instrument. If these means fail, a small bistoury must be introduced flatwise beneath the edge of the preputial orifice, which lies at the bottom of the groove behind the swollen glans, and then turned with its edge upwards so as to nick the constricting tissues at one or more points of their circumference; the tension being thus relieved, reduction can be accomplished without difficulty.

INFLAMMATORY AFFECTIONS OF THE PENIS AND SCROTUM.

Diffuse Inflammation of the Areolar Tissue of the Penis and Scrotum may result from erysipelas or urinary extravasation, or may occur as a sequela of certain fevers—particularly variola and scarlatina. The parts become greatly swollen, constituting the condition often spoken of as inflammatory œdema, and gangrene is apt to ensue. The *treatment* consists in making free incisions, and in elevating the parts and applying warm fomentations; quinia and iron may be given in pretty large doses, while the strength of the patient is kept up by the administration of concentrated food and stimulants.

Gangrene of the Penis is a serious affection which may result from either phimosis or paraphimosis, as it may, likewise, from traumatic causes, such as the introduction of the organ into a ring, the impaction of a calculus in the urethra, wounds of the cavernous bodies, etc. Gangrene of this part has also been observed as the result of phagedænic ulceration, of phlebitis of the dorsal vein, and of urinary extravasation; and has been seen in the course of low fevers. Usually the prepuce only is affected; but occasionally the skin of the whole penis or even the entire organ may be implicated. When either the prepuce or the glans is threatened with gangrene, no time should be lost in slitting up the former, so as to relieve the part from tension. When gangrene has actually occurred, little can be done beyond supporting the strength of the patient, and facilitating the separation of the sloughs as they become detached. Demarquay speaks favorably of the actual cautery as a means of preventing the spread of the disease. The affection may prove directly fatal, through simple exhaustion, through the development of pyæmia, or through the occurrence of secondary hemorrhage; or may indirectly cause death, according to Demarquay, by the patient falling into a state of marasmus, caused by the impairment of the generative powers. In other cases, in spite of the loss of considerable portions of the penis, the procreative powers of the patient have not been at all diminished.

Herpetic and Aphthous Ulcerations on the penis are chiefly interesting on account of the probability of their being mistaken for chancroids (see p. 444). The *treatment* consists in the use of astringent applications, such as the oxide of zinc in powder, or lotions of borax, and in attention to the state of the general health.

Thrombosis of the Corpus Cavernosum.—Prescott Hewett has described two cases in which, in persons of a gouty tendency, spontaneous thrombosis occurred in patches in the cavernous body of the penis. The chief interest attaching to the affection is its liability to be mistaken for syphilis or cancer, from either of which, however, it may be distinguished by its essentially chronic character, and by the fact that the inguinal glands are not involved. No treatment is required. Since the publication of Hewett's paper, similar cases have been described by Van Buren and Keyes, and by Howard Marsh. Thrombosis of the dorsal vein of the penis has been observed by Lucas.

Balanitis and Posthitis have already been considered (see page 438).

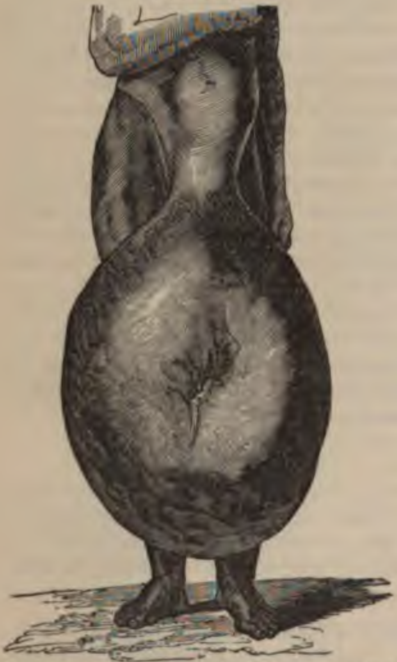
STRUCTURAL CHANGES IN THE PENIS AND SCROTUM.

Hypertrophy of the Prepuce may result from long-continued irritation of the part, or may be due to a condition of *Elephantiasis Arabum* (see pp. 480, 517)—in which case the subcutaneous tissues of the penis are commonly affected in a similar manner, as may be also the scrotum. The *treatment* consists in the excision of the enlarged prepuce and of a V-shaped piece from the dorsum of the glans penis, the sides of the wounds being brought together with stitches.

Hypertrophy of the Corpora Cavernosa has been observed in one case recorded by J. G. Kerr, of Canton. The affection does not appear to admit of operative treatment.

Hypertrophy or Elephantiasis of the Scrotum is chiefly seen in warm climates. The disease anatomically resembles what has been described as the *fibro-cellular outgrowth* (p. 480), and can only be removed by excision. When of moderate dimensions, the hypertrophied scrotum can be removed with little risk; but, when, as not unfrequently happens, the part forms a pendulous tumor weighing from 40 to 80 or even 165 pounds (as in a case mentioned by Van Buren and Keyes), the operation becomes one of a formidable nature. To diminish the loss of blood, which is always considerable, the tumor should be elevated above the rest of the body for some hours before the operation, as advised by Brett and O'Ferrall, and the neck of the tumor may be compressed with a clamp, as recommended by Fayrer; with a running noose, as ingeniously suggested by Dr. Mactier; or with an Esmarch's tube, as practised by Partridge and Cayley, of Calcutta. If a *hernia* be present, this should be first fully reduced.

FIG. 541.



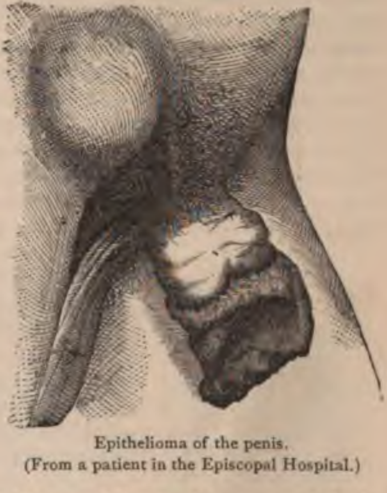
Hypertrophy or elephantiasis of the scrotum, in a Hindoo. (TITLEY.)

The operation may be performed by introducing a director down to the penis, which lies at the bottom of a sinus, deeply buried in the mass, and upon the director a catlin, which is made to transfix the superincumbent tissues and cut its way outwards. The penis is now carefully dissected out and held up towards the abdomen, when incisions are made on each side so as to expose the testes, which are similarly dissected out and turned up until the operation is completed. The tunicæ vaginales, if diseased, are to be cut away, and then the whole mass separated by cutting across its base close to the perineum. Hemorrhage is next to be suppressed, 50 or 60 ligatures being sometimes required for this purpose, and the wound is then to be simply dressed with oiled lint and allowed to heal by granulation. The testes and penis quickly become covered, and cicatrization is usually completed in from six weeks to two months. If, in the case of a very large tumor, it is found that the dissection of the testes would prolong the operation beyond from three to five minutes, Fayrer advises that the attempt to save these organs should be abandoned, and the whole mass swept away as quickly as possible. Of 28 patients operated on by Fayrer, 22 recovered and 6 died, one from shock, and the other 5 from pyæmia. The same surgeon, from an analysis of 193 cases, finds the general death-rate of the operation to be 18 per cent., but a recent writer, Dr. G. A. Turner, who practised as a medical missionary in the Samoan Islands, claims to have operated 136 times with only two deaths. Dr. Kerr, of Canton, has modified this procedure by covering in the testes with flaps taken from the sides of the scrotum.

Vegetations or Warts on the penis, *Venereal Warts*, as they are often, though incorrectly, called, have already been referred to (see page 511).

Vascular Tumors, or Angeiomata of the penis, are occasionally met with, and may be treated by excision, the application of caustics, the establishment of a seton (Reeves), or even, as in a remarkable case reported by Parona, by amputation of the organ. The same surgeon has successfully employed injections of chloral in a case of *varix* of the dorsal vein of the penis.

FIG. 542.



Epithelioma of the penis.
(From a patient in the Episcopal Hospital.)

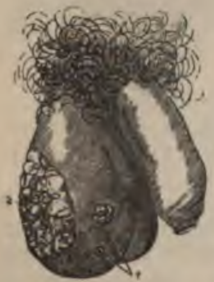
Malignant Diseases of the Penis.—The penis may be the seat of either *epithelioma* or *scirrhus*, the former, which is the more common affection, ordinarily beginning in the prepuce, while scirrhus usually originates in the body of the penis, in the depression behind the corona glandis. Both of these forms of disease appear to be more common in the subjects of congenital phimosis than in those who are not thus affected, which is of itself a sufficient reason to induce the surgeon to recommend circumcision in all cases of preputial contraction. Epithelioma of the penis may possibly be mistaken for exuberant vegetations or for chancre. From the former it may be distinguished by the indurated and infiltrated condition of the parts, which is characteristic of the malignant affection, and from the latter by the history and course of the disease, the comparatively late implication of the inguinal lymphatic glands, and the negative effect of antisyphilitic treatment.

Treatment.—In the case of *epithelioma*, if the nature of the affection be recognized before the glans has become involved, it may be possible to remove the whole mass of disease by circumcision; but at a later period amputation of the penis is the only resource which offers a prospect of benefit, and the same operation is required when the growth is of a scirrhous character.

Amputation of the Penis, if performed at an early period, before the lymphatic glands have become involved, is quite a successful proceeding, and often gives a long respite from the disease, if, indeed, it does not effect a permanent cure. The operation may be performed with either the wire loop and galvanic cautery, the *écraseur*, or the knife. The disadvantage which attends the use of the *écraseur*, is that the contraction which ensues in healing is apt to diminish the calibre of the urethra, and thus lead to difficulty in micturition; to avoid this, it has been recommended to introduce a flexible cathether, cut through this with the chain of the instrument, and leave the remnant in place during the process of cicatrization; but it is not always very easy to sever the catheter in this manner, and, unless great care be exercised, its end may escape from the surgeon's grasp and slip into the bladder. Upon the whole, the operation with the knife seems to be preferable under ordinary circumstances, though if it be necessary to amputate the organ very high up, the *écraseur* may answer a better purpose. Humphry, Thiersch, Cabadé, C. Johnston, McGann, and Gould have successfully removed the entire organ, connecting the divided urethra with an artificial opening in the perineum.

To prevent hemorrhage, in the use of the knife, a tape may be tied tightly around the root of the penis, and an assistant should grasp the part with his fingers to prevent the stump from being retracted beneath the pubis, or, as advised by Tyrrell, the penis may be transfixed with a large acupressure pin, behind which the tape is applied, the pin itself being left in place for several days, and until all risk of bleeding has passed by. The surgeon takes the glans, wrapped in lint, in his left hand, and draws the organ forwards, so as to put its integument on the stretch; he then cuts off the part to be removed with a sharp knife, either at a single stroke, or, which I think better, divides first the cavernous bodies, and then allows the organ to retract before severing the urethra, which is thus left rather longer than the rest of the penis. Bleeding is next to be checked, about five ligatures usually being required, when the operation should be completed according to Ricord's plan, by splitting the projecting portion of the urethra at three or four points and everting its mucous membrane, which is then attached to the skin by means of the interrupted suture. Another plan, suggested by Watson, of Edinburgh, is to make a slit in the integument of the penis, and to pass the projecting urethra through this slit, so as effectually to prevent the occurrence of contraction during the healing process.

FIG. 543.



Epithelioma of the scrotum. (CURLING.)

Unless the amputation be done very near the root of the organ, the procreative powers of the individual do not seem to be impaired by the operation.

Non-malignant Tumors of the penis are occasionally met with, and may be removed without infringing upon the integrity of the rest of the organ.

Epithelioma of the Scrotum is chiefly observed in chimney-sweepers,[1] whence it has been called *chimney-sweeper's* or *soot cancer;* it appears to be produced by the irritation caused by the contact of soot, beginning as a scaly or incrusted wart which soon ulcerates, and perhaps ultimately involving the whole scrotum, the testis, and the inguinal and pelvic lymphatic glands. The *treatment* consists in complete excision of the growth, at as early a period as possible. Under the name of "*paraffine epithelioma,*" Joseph Bell describes a form of malignant ulceration met with in workers in this article. The *treatment* consists in excision.

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[1] In the only cases seen by the late J. C. Warren, of Boston, however, the patients were not chimney-sweepers.

MALFORMATIONS AND MALPOSITIONS OF THE TESTES.

Complete Absence of one or both Testes has occasionally been observed, but a more common condition is an *Arrest in the Normal Descent of the Organ,* the gland remaining in the abdominal cavity or in some part of the inguinal canal. In other cases a testis may pass through the femoral ring, may be found in the perineum, or, though lodged in the scrotum, may be inverted, so that the epididymis is placed in front of the body of the organ. Retained testes are liable to become inflamed, and are peculiarly predisposed to structural degeneration. It would appear, also, from the researches of Godard and Curling, that a retained testis either secretes no fluid, or that its secretion is destitute of spermatozoa; hence a *monorchid*, or person with one undescended testis, depends for his procreative power upon the single gland which has reached the scrotum, while a *cryptorchid*, or person with both testes retained, though capable of coition, is necessarily sterile.

Treatment.—The treatment of malpositions of the testis is in most cases limited to palliative measures. If the gland be still within the abdomen at the end of the first year of life, Curling advises the application of a truss to insure its permanent retention. When the testis is above the external ring, it requires no treatment, unless it becomes inflamed, or is the seat of structural degeneration. When at or just outside of the external ring, the gland is liable to slip backwards and forwards, and causes a good deal of pain when pinched in the inguinal canal. Under such circumstances, a truss should be used, the pad being applied, if possible, between the testis and ring; if this can not be done, the gland may be pushed into the canal and held there with a truss provided with a suitable obturator, as advised by Curling, or a truss with a concave or ring pad to receive the gland, may be employed, as recommended by J. Wood. Annandale has successfully transplanted a misplaced testis from the perineum to the scrotum; but a similar operation in the hands of J. E. Adams terminated fatally from peritonitis. Transplantation of a testis from the groin to the scrotum has been successfully resorted to by J. Wood.

If a testicle which is retained in the inguinal canal becomes *inflamed*, the affection may at first sight be mistaken for strangulated hernia, but may commonly be distinguished in the way described at page 818. The *treatment* consists in the application of leeches, followed by ice or hot fomentations, as most agreeable to the patient, with the internal administration of laxatives and saline diaphoretics. If the gland be subject to repeated attacks of inflammation, the question of *excision* may properly be considered; the operation is usually successful, 42 cases collected by Monod and Terrillon having given 35 recoveries and but 7 deaths—only one of these, moreover, having been due to peritonitis. Excision is always required in case of structural degeneration of a retained testicle, and may also be practised when the organ is situated in the perineum, in which position it is constantly exposed to injury.

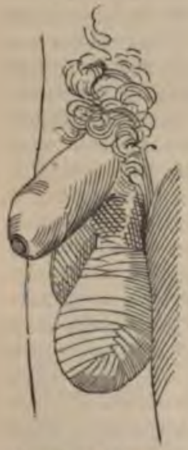
Inversion of the Testicle is chiefly interesting when accompanied with hydrocele, the fluid then being found behind the organ, instead of in front of it, as is usually the case.

H. Lee has recorded a curious instance of *Temporary Disappearance of the Testicle*, the organ having slipped up through the inguinal ring, which was dilated by the presence of a hernia. The patient was directed to go without the truss for a few days, when the missing gland reappeared. Dr. Humphry refers to a case in which the organ similarly vanished during the act of masturbation, but in this instance the disappearance was unfortunately permanent.

ORCHITIS.

Orchitis, or *Inflammation of the Testicle*, may result from traumatic causes, from rheumatism, from mumps, or from the spread of gonorrhœal or other inflammation from the urethra. In the latter cases, the epididymis is commonly the part primarily affected, constituting the affection known as *Epididymitis*, *Hernia Humoralis*, or *Swelled Testicle*, which has already been described at page 436. The *symptoms* of orchitis are those of inflammation in general, the pain being very intense, and often radiating up the course of the spermatic cord. There is usually effusion into the tunica vaginalis (acute hydrocele), and there is often a great deal of constitutional disturbance. The *treatment* is essentially the same, no matter what may be the origin of the affection. When the symptoms are very acute, I know of nothing which will afford such rapid relief as the puncture of the tunica albuginea, in the way recommended by Vidal (de Cassis) and H. Smith. In less acute cases, it may be sufficient to confine the patient to bed, and to keep the scrotum elevated and covered with cold lead-water and laudanum. Laxatives and anodyne diaphoretics, followed at a later period by quinia, may be administered internally. In *chronic* cases, in which the enlargement of the organ continues after the subsidence of all acute symptoms, strapping of the testicle may be resorted to with advantage. This may be done with simple adhesive plaster, or with the plaster of ammoniac and mercury, if there be any suspicion of a syphilitic taint.

FIG. 544.

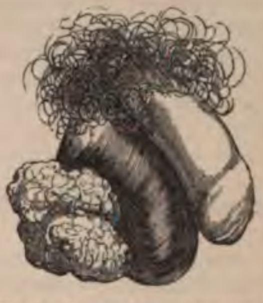


Strapping the testicle. (VELPEAU.)

Strapping the Testicle.—The scrotum having been carefully washed and shaved, the surgeon draws the skin of the affected side upwards, so that the part which covers the testicle is tensely stretched over the organ. A strip of plaster is then applied circularly above the gland and drawn pretty closely, so as to isolate the part and prevent the other strips from slipping. These are now applied, in an imbricated manner, alternately in a longitudinal and transverse direction, until the whole organ is covered in and firmly and evenly compressed, no one strip, however, being drawn so tightly as to produce excoriation. When properly applied, the effect of strapping in promoting absorption, and thus reducing the size of the part, is very striking. The dressing commonly requires renewal every day or every other day, and upon each occasion the scrotum should be well washed with Castile soap and water, so as to keep the skin in a healthy condition.

Abscess and Hernia of the Testicle.—*Abscess* is an occasional sequel of orchitis, the pus being usually formed in the tissues of the scrotum rather than in the testicle itself, but sometimes originating beneath the tunica albuginea, in the proper gland structure. In the former case, the affection is of but little consequence, the abscess healing without difficulty after the evacuation of its contents; but when the testicle itself is the seat of suppuration, a fistulous opening is apt to remain, through which a portion of the seminiferous tubules may protrude, in the form of a vascular, fungoid mass. The *treatment* of this *Hernia of the Testis*, as it is called, consists in the topical use of stimulating astringents, such as the red oxide of mercury, with pressure—which may be applied with adhesive strips, or, better, as recommended by Syme, by making elliptical incisions around the protruding mass and loosening the surrounding integument, which is then united over the protrusion with sutures—thus making the skin of the part exercise the requisite compression. If one testicle only be affected, and the patient's health begins to fail under the long continuance of the disease, castration may occasionally be justifiable.

FIG. 545.



Hernia of the testicle. (CURLING.)

NEURALGIA OF THE TESTIS.

The seat of pain may be the epididymis, the body of the testicle itself, or the spermatic cord. The part is usually extremely sensitive to the touch, and there may be slight swelling without any evidence of positive disease. The pain is often of a paroxysmal character. The affection is sometimes associated with an irritable condition of the urethra, and with the occurrence of involuntary seminal discharges. In other cases, it depends upon the existence of varicocele, or may be sympathetically excited by hemorrhoids. Often, however, neuralgia of the testicle exists without any apparent cause. The *treatment* consists in removing any source of irritation that can be discovered, and, in cases of obscure origin, in the administration of tonics and antispasmodics, and in the topical use of sedatives and anodynes. Galvanism has occasionally proved serviceable in these cases. Castration has been recommended, and is often desired by the patient. It is, however, an unjustifiable operation under these circumstances, as being totally uncalled for in cases of local origin, and only capable of affording temporary relief, if any, in those of a constitutional nature. Hammond recommends forcible compression of the spermatic cord—an operation somewhat analogous to that of nerve-stretching.

HYDROCELE AND HÆMATOCELE.

Hydrocele of the Tunica Vaginalis, or simply *Hydrocele*, consists in a collection of serous fluid in the tunica vaginalis. Several varieties of the disease are described by surgical writers, as the *congenital*, the *acquired*, and the *encysted hydrocele*. *Inguinal hydrocele* is a name used by Holthouse for hydrocele occurring in connection with an undescended testis.

Congenital Hydrocele results from an imperfect closure of the communication between the tunica vaginalis and the peritoneal cavity. This form of hydrocele is observed in infants, and may be recognized by the flui flowing back into the abdominal cavity when the scrotum is elevated o compressed. Congenital hydrocele usually undergoes a spontaneous cur by the closure of the vaginal process of peritoneum; if, as often happen the hydrocele be accompanied with hernia, a truss should be worn to pr vent the descent of the intestine. Should a congenital hydrocele not di appear spontaneously, discutient remedies, such as a lotion containin muriate of ammonium, or the tincture of iodine (diluted), may be applied t the scrotum, or acupuncture may be tried, or the fluid may be evacuate with an exploring trocar and canula, and a little alcohol injected whil compression is maintained upon the inguinal canal. This plan, which i recommended by Richard, is, however, necessarily attended with some ris of peritonitis.

Acquired Hydrocele may originate in an attack of orchitis, which, as ha been mentioned, is usually accompanied with effusion into the tunica vagin alis, but more commonly begins as a chronic affection, sometimes followin a blow, but often being assignable to no particular cause. It may occur a any age, but is probably most common in infants, and in adults about th middle period of life.

The *symptoms* are swelling, beginning at the lower part of the scrotum and attended with a sensation of weight and dragging, but rarely with pain The swelling is at first (usually) soft, fluctuating, and elastic, but ultimatel becomes tense and hard, and assumes a pear-like shape which is very char acteristic. The size varies from that of a hen's egg to that of a large orange sometimes even exceeding the latter measurement. As the swelling creep up the cord to the external abdominal ring, it covers over and partially con ceals the penis.

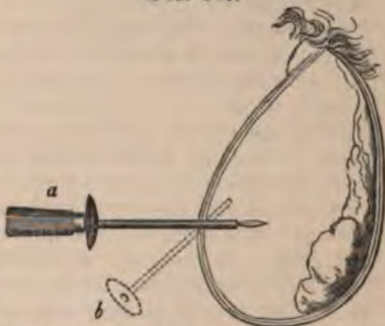
The *diagnosis* can usually be made without difficulty, by noting the pyri form character of the tumor, and by observing that the swelling of hydro cele is translucent when examined by transmitted light. For this test the patient should be in a dark room, and the surgeon should grasp the neck of the hydrocele with one hand, so as to put the integument on the stretch, while the edge of the other hand is applied to the convexity of the swelling so as to shade it from side rays; a lighted candle or lamp being then held by an assistant close behind the tumor, this will in the large majority of cases be found translucent. This test may, however, occasionally fail, either from the dark color of the contained liquid, or from the thickness of the superincumbent tissues, while on the other hand a solid tumor may occasionally be translucent, as in a case of round-celled sarcoma, recorded by Lucke, and in one of hernia (in a child), mentioned by Howse; hence in some circumstances an exploratory puncture or incision may be required to reveal the true nature of the affection. For the diagnosis from *hernia*, see page 819.

The fluid of a hydrocele varies in quantity in different cases, the amount being usually from six ounces to a pint, but occasionally reaching to several quarts; it is commonly of a straw color and limpid, and is albuminous, coagulating sometimes into a solid mass when heated; in other instances it is of a dark brown color, from the admixture of blood, and it then usually contains cholestearine. It is occasionally of a milky or chylous character, and contains leucocytes and fatty matter. In some rare cases it coagulates spontaneously. The tunica vaginalis, or *Sac of the Hydrocele*, and its other coverings, are usually thinned by distension, but otherwise normal; in some cases, however, the sac is thickened—becoming the seat of a pseudo-membranous formation which may send prolongations across the cavity in the form of bands or septa—or more rarely undergoes calcification; in these cases the resulting pressure may cause atrophy of the testicle, but in most instances this organ is normal or slightly enlarged. The *position of the testis*, in hydrocele, is almost always at the lower and posterior part of the scrotum, but it may occasionally be in front (from congenital inversion of the organ), or its position may be altered by the formation of adhesions between the opposing surfaces of the tunica vaginalis. The position of the testis should always be, if possible, ascertained (by examination with transmitted light) before resorting to operation. The two tunicæ vaginales are affected with about equal frequency, and *double hydrocele* is occasionally observed; in this case the existence of a communication with the abdominal cavity may always be suspected.

The *treatment* of acquired hydrocele may be either palliative or radical. In infants and young children, a cure may often be effected by the application of discutients, or by acupuncture, as in the congenital form of the affection; and, even in adults, a single tapping (which constitutes the palliative mode of treatment) will occasionally afford permanent relief, though, more commonly, the effusion returns after each tapping, the hydrocele re-acquiring its original size in the course of a few months. Occasionally the intervals between the successive returns of the disease become gradually longer, until, after repeated tappings, the affection ultimately disappears.

Tapping a Hydrocele, or the *Palliative Operation*, is attended with very little risk, though, in aged subjects, death may occasionally follow from the occurrence of diffuse inflammation of the connective tissue of the part. The surgeon, having determined the position of the testicle, grasps the hydrocele with his left hand so as to make the skin tense, and choosing a point which is at the opposite side from the gland, and free from subcutaneous veins, introduces, with a quick plunging motion, a small trocar and canula, at about the junction of the middle and lower thirds of the scrotum. The instrument should be at first thrust directly backwards, but as soon as the point has entered the sac should be inclined in an upward direction (Fig. 546), so as to avoid wounding the testicle—an accident which, though rarely followed by any evil result, should, if possible, be avoided. The trocar is then withdrawn, when the fluid escapes through the canula, and is caught in any convenient receptacle. The operation is attended with very little pain, and the patient need not therefore be etherized; he may be placed in the recumbent position, or, which I prefer, if the hydrocele is not a very large one, may sit on the edge of a high chair, or stand, leaning against a table. The surgeon should examine his trocar before using it, to make sure that it has a good point, and that it fits and slips easily in the canula; from neglect of this precaution, I have seen a surgeon introduce his instrument, and then find that the trocar could with great difficulty be extricated from the canula, into which it was firmly rusted. After the withdrawal of the canula, a piece of sticking-plaster may be put over the puncture, but no further after-treatment is required. Bradley, of Manchester, recommends that the part should be

FIG. 546.



Tapping for hydrocele; *a*, introduction of trocar; *b*, position of canula. (ERICHSEN.)

tightly strapped after tapping, and believes that thus re-accumulation may be prevented. The palliative treatment may be properly employed if the patient cannot spare the requisite time from his ordinary avocations to undergo the operation for the radical cure, and in the case of very old or feeble men who might illy support the risk of the operation. Simple tapping may also be employed once or twice as a preliminary to the radical treatment, which is most apt to succeed when the disease is in a chronic condition.

Radical Treatment of Hydrocele.—Various operations are performed with a view of effecting a permanent cure of hydrocele, those most worthy of mention being the methods by *injection*, by the *formation of a seton*, by *incision*, and by *excision of the tunica vaginalis.*

1. *Injection.*—The fluid of the hydrocele having been evacuated with the trocar and canula, some irritating substance may be injected through the latter, so as to excite inflammation in the tunica vaginalis. The *modus operandi* of injections, in cases of hydrocele, appears to be in most cases the formation of inflammatory lymph, which glues together more or less completely the opposing surfaces of the sac; in some instances, however, no adhesions have been found on dissection, and the cure has appeared, therefore, to be due to some intangible change in the tunica vaginalis itself. The injection treatment is very rarely followed by suppuration. Various substances[1] have been employed for the injection of hydrocele, the best being the tincture of iodine, as originally suggested by Sir J. Ranald Martin. Some surgeons use the tincture largely diluted, allowing the injected fluid to flow out again through the canula before the latter is withdrawn; but Syme's plan, which I have always followed, and which, when properly carried out, almost never fails, is to inject a small quantity of the pure tincture (f℥j to iij, according to the size of the swelling), and allow it to remain in the sac. The injection may be made with an ordinary penis syringe; or, which is more convenient, a gum-elastic bag with a nozzle and stopcock; and it is better to use a platinum canula instead of one made of silver, as the latter metal may be corroded by contact with the iodine. After the injection, the canula should be cautiously withdrawn, so as to prevent the escape of the fluid, which should then be diffused over the whole surface of the sac by giving the part a shake. A good deal of pain usually follows the operation, and the scrotum commonly swells to its original size in the course of a few days, the swelling then gradually subsiding until the cure is complete. In this stage of the treatment, the progress of the cure may be hastened by systematically strapping the part with adhesive plaster. The patient should be confined to bed, or at least to a lounge, for two or three days; but after that may resume his ordinary occupations.

2. *The Seton.*—Should the injection treatment fail (which, I may repeat, will very seldom happen if the surgeon use the pure tincture of iodine, and allow it to remain in the sac), the next best plan is to establish a seton. This may conveniently be done by replacing the trocar in the canula, after evacuating the contents of the sac, and then making a counter-puncture from within outwards; the trocar is now withdrawn, and an eyed-probe, carrying two or three strands of silk, passed through the canula, which is finally removed, leaving the threads in place. The ends are then loosely knotted and the patient sent to bed. The threads may, in most instances, be removed the next day, or the day after; but occasionally must be left a week

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[1] Among those most highly recommended of late years may be mentioned carbolic-acid, as used by Levis and Weir, and powdered iodoform, as employed by P. J. Hayes, of Dublin.

or even longer, to produce the required amount of inflammation. Furneaux Jordan recommends that, to increase the irritation, the threads should be moistened with iodine liniment. The use of *wire* was recommended by Simpson, with the expectation that it would be less apt to excite troublesome suppuration than the seton made with silk. The experience of surgeons generally has, however, shown that such is not the case, while it has been found that the wire seton is by no means a certain remedy.

3. *Incision.*—This consists in laying open the sac and stuffing the wound with lint, so as to induce suppuration. Though an efficient mode of treatment, this is in most cases unnecessarily severe, and is not entirely free from risk. It is particularly adapted to cases in which the thickness of the sac prevents the diagnosis from being made by the examination with transmitted light; if such a case be really one of hydrocele, the incision will suffice for its cure, while, if it turn out to be one of solid tumor, the wound can be utilized for the operation of castration.

4. *Excision.*—This consists in laying open the sac, and carefully dissecting out the tunica vaginalis. If the operation succeeds, the cure is necessarily permanent; but the procedure is a dangerous one, and should be kept as a last resort for cases that resist all other modes of treatment.

Encysted Hydrocele (*Spermatocele*).—In this affection the fluid is not contained, properly speaking, in the tunica vaginalis, but in an independent cyst projecting from the surface of the testicle, or more commonly from the epididymis. In the latter case, the fluid of the cyst differs from that of an ordinary hydrocele in being watery or milky, and in containing spermatozoa; and the name *spermatocele* is therefore properly applied to these, which belong to the class of *seminal cysts* (see p. 476). Those comparatively rare specimens of encysted hydrocele, however, in which the cyst projects from the body of the testis, cannot be so classed, as they do not appear to contain spermatozoa—their fluid being of a serous character like that of the common hydrocele. This variety, as pointed out by Osborn, appears to originate in dilatation of the so-called "hydatid of Morgagni," a remnant of the Müllerian duct of fœtal life. The *diagnosis* of the encysted from the other forms of hydrocele, can usually be made by observing the position of the testis in relation to the sac, which, in the encysted variety of the disease, commonly projects from the surface of, but does not surround, the gland. The *treatment* is the same as for the ordinary acquired hydrocele.

Fibrous or Fibro-cartilaginous bodies are sometimes found in the sac of a hydrocele; they resemble in structure the rice-like bodies found in synovial bursæ, and, if recognized during life, may be removed by a simple incision.

Hydrocele of the Spermatic Cord.—Three varieties are described by systematic writers, viz.: (1) the *simple* hydrocele of the cord, which consists in an accumulation of serous fluid in the cavity which often persists in the funicular portion of the vaginal process of the peritoneum; (2) the *encysted* hydrocele of the cord, in which the fluid is contained in an independent cyst developed in this situation; and (3) the *diffused* hydrocele of the cord, a rare affection, referred to by Pott and Scarpa, which appears to consist in an œdematous infiltration of the areolar tissue of the part. For the diagnosis of hydrocele of the cord from hernia, see page 818. The *treatment* of the simple and encysted varieties, consists in tapping, followed, if necessary, by the injection of iodine, or the formation of a seton. For the diffused hydrocele—if any treatment were required—the external use of iodine or other sorbefacients might be resorted to.

Hydrocele of the Seminal Vesicle is the name applied by N. R. Smith to a cyst developed in connection with the organ referred to; it is a rare affection and may be mistaken for a distended bladder, but the *diagnosis* can be readily made by the use of a catheter and by the introduction of a finger into the rectum. The *treatment* consists in evacuating the contents of the cyst by tapping through the rectum, as in cases of urinary retention. (See page 943.)

Hæmatocele.—Of this there are three varieties, viz.: (1) *hæmatocele of the tunica vaginalis*, consisting in an effusion of blood into this sac, and often supervening upon an ordinary hydrocele; (2) *encysted hæmatocele*, in which the blood is effused into the sac of an encysted hydrocele; and (3) *hæmatocele of the cord*, in which the effusion occupies a position corresponding to that of a hydrocele of this part. Hæmatocele may result from *traumatic* causes—such as a blow or squeeze, or possibly the wound of a small vessel inflicted in the operation for hydrocele—or may originate *spontaneously* from the rupture of a spermatic vein. In the spontaneous cases, which are comparatively rare, the hæmatocele sometimes attains a very large size, and the affection is, under these circumstances, attended with considerable danger. The blood of a hæmatocele is at first of course fluid, and may continue in this state for many years; in other cases, it undergoes partial coagulation, the clots sometimes assuming a laminated arrangement like that seen in the sac of an aneurism; or the blood corpuscles may become disintegrated, when the fluid of the hæmatocele has a dark and grumous appearance, and often contains cholestearine; if decomposition of the blood occurs, suppuration of the sac may ensue, and perhaps lead to fatal consequences.

The *symptoms* are much the same as those of hydrocele, except that the part is not translucent when examined by transmitted light. The *diagnosis*, in the early stages of the affection, can commonly be made by observing that the swelling occurs rapidly, and usually after a blow—and yet is obviously not due to orchitis—while the absence of translucency, and the existence of ecchymosis, serve to distinguish the affection from hydrocele. When hæmatocele has passed into a chronic condition, the diagnosis is more difficult, and in many cases the disease has been mistaken for cancer, and *vice versâ*. Humphry points out that the cancerous testis steadily increases in size, while the growth of a hæmatocele is irregular, and the swelling sometimes even undergoes diminution. The diagnosis from hernia has already been considered at page 819.

Treatment.—In many cases hæmatocele undergoes a spontaneous cure; the hemorrhage ceases, and absorption then gradually occurs, as in the case of blood effused in other parts of the body. Hence, in the early stages of the affection, the treatment should be merely palliative, consisting in the enforcement of rest, with elevation of the scrotum, the application of cold, etc. After a few days, the patient may go about with a suspensory bandage. If, however, the hæmatocele be in a chronic state, tapping may be resorted to, and will occasionally effect a cure; should the sac refill, its contents will probably be thinner and more serous than at first, and the case will thus gradually become assimilated to one of hydrocele, when it may be treated with iodine injections. If the hæmatocele contain a large proportion of coagulum, it will probably be necessary to lay the sac open and allow it to heal by granulation. This should not, however, be done during the early stages of the affection, particularly in a case of the spontaneous variety, lest dangerous or even fatal hemorrhage should take place from the ruptured vein, which is sometimes very much enlarged. Before either puncturing or incising a hæmatocele, the surgeon should, if possible, determine the position of the testis; this cannot be ascertained, as in the case of hydrocele, by examination with transmitted light, but much information may often be gained by tracing down the cord, and by noting the sensations of the patient, who usually experiences a characteristic, sickening pain when pressure is made on the testicle.

VARICOCELE.

Varicocele, or *Cirsocele (varicose enlargement of the veins of the spermatic cord*) is a very common affection, existing, according to Humphry, in about ten per cent. of all male adults. The *causes* of varicocele are those of varix in general; the anatomical peculiarities of the spermatic veins render them particularly susceptible to the affection, which is chiefly seen in those of lax and feeble habit, and is often hereditary. Varicocele is much more frequently seen on the *left* side than on the *right:* this appears to be due to a combination of causes, such as the position of the left testicle, which is usually more dependent than the right; the obstacle to the return of blood which exists on the left side, from the left spermatic vein joining the renal vein at a right angle, instead of opening directly into the vena cava, as is done by the right spermatic vein; the comparative deficiency of valves in the left spermatic vein as compared with the right (first pointed out by Dr. J. H. Brinton, of this city); and the exposure of the left spermatic vein to pressure, from accumulations of fecal matter in the sigmoid flexure of the colon.

Symptoms.—Varicocele forms a pyramidal swelling in the scrotum, with its base downwards, and its apex extending upwards towards the inguinal canal. The swelling has a peculiar knotted and convoluted feel, and the sensation conveyed to the hand is often compared to that which would be given by a bunch of earthworms. The tumor increases when the patient stands or walks, and almost if not quite disappears when he lies down. It is sometimes, but by no means always, attended with a feeling of weight and even pain, which is increased by exercise, and is apt to be worse in summer, when the scrotum is more relaxed and pendulous than at other seasons. Varicocele sometimes attains a considerable size, filling the scrotum and enveloping the testicle, which may undergo diminution in bulk from the pressure of the overlying veins. Rupture of a varicocele may occur from a blow or other injury, causing great effusion of blood; Erichsen mentions a case of this kind in which, the tumor having been opened, the patient died from venous hemorrhage.

The *diagnosis* of varicocele from hernia (the only affection with which it is likely to be confounded) has been considered at page 819.

Treatment.—In the large majority of cases, no treatment whatever is required: the patient may wear an elastic suspensory bandage, to support the part and relieve the feeling of weight which sometimes accompanies the affection, but even this apparatus is in many instances voluntarily thrown aside. To lessen the capacity of the scrotum, its lower part may be drawn through a soft metallic ring covered with leather, or one of vulcanized India-rubber; this plan, which was suggested by Wormald, would certainly be attended with less risk than that by which it appears to have been suggested, viz., excision of the lower portion of the scrotum, as recommended by Cooper and Briggs, and more recently by M. H. Henry, of New York, who has devised an ingenious clamp for the prevention of hemorrhage during the operation, an object sought to be attained by Hutchison, of Brooklyn, by first transfixing the scrotum half a dozen times with a large acupressure needle. The *hypodermic injection of ergotine* is recommended by two Italian surgeons, Drs. Bertarelli and Cittaglia, and is certainly worthy of further trial. But the best palliative remedy for varicocele is, I think, the application of a light truss, as recommended by Curling and Ravoth, so as to break the column of blood in the spermatic veins (without compressing the artery), and thus remove the pressure from the dilated vessels.

Radical Cure of Varicocele.—In a few cases, more energetic measures may be required; a great many operations besides that of Cooper, above referred to, have been proposed for the radical cure of varicocele, the best, probably, being those of Ricord, Vidal (de Cassis), H. Lee, J. Wood, and Annandale.

(1.) *Ricord's Method* consists in introducing subcutaneously, in opposite directions but through the same apertures, two double ligatures, one beneath the spermatic veins (isolated from the vas deferens), and the other above them, so that there shall be a loop and two ends of ligature on each side; the ends are then threaded through corresponding loops, and attached to a light yoke provided with a screw, by daily turning which they are constantly drawn tight—thus effectually strangulating and ultimately cutting through the veins, from which the ligatures drop in the course of the second or third week.

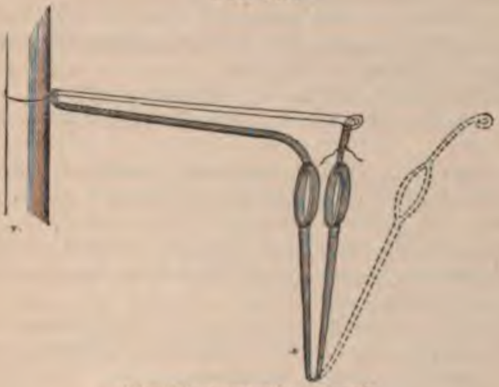
(2.) *Vidal's Operation* consists in passing a steel pin, perforated at both ends, *below* the veins and between them and the vas deferens, and through the same apertures a silver wire *above* the veins, and between them and the skin; the wire is threaded through the perforations at each end of the pin, which is then rotated in such a way as to twist the wire and roll up and firmly compress the veins. The wire is twisted more and more tightly each day until the veins are cut through (usually at the beginning of the second week), when the pin and wire are easily withdrawn together. Bradley has simplified this method by passing a long pin *above* and then *below* the veins, thus compressing them as in the "Aberdeen" method of acupressure.

(3.) *Lee's Method* consists in passing two needles beneath the veins, and between them and the vas deferens, about an inch apart—pressure being then made by means of elastic bands passed over the extremities of the needles. The veins which are thus acupressed at two points, are next divided subcutaneously between the needles, which may be removed on the third or fourth day after the operation. Should the division of the veins be followed by bleeding, which may happen from some vessel being cut that was not included by the needles, the hemorrhage can be readily arrested by the introduction of a third needle—*below* the point of division if the bleeding be venous, and *above*, if it be of an arterial character. I have varied this operation by acupressing the veins between hare-lip pins and loops of silver wire passed subcutaneously. Another method, recommended by the same surgeon, consists in cutting away a portion of the scrotum, compressing, dividing, and searing with a hot iron the affected veins, and finally closing the wound with a carbolized suture. Bogue, of Chicago, cuts into the scrotum antiseptically, and ties each vein separately with a catgut ligature.

(4.) *Wood's Method* is an ingenious modification of Ricord's, in which the veins are surrounded subcutaneously with a metallic ligature; the ends of the ligature pass through and are secured to a light spring, by the action of which the wire is constantly drawn tight. Somewhat similar methods are practised by Barwell, and by Weir, of New York. Gould surrounds the veins with a platinum wire, and divides them with the galvanic cautery.

(5.) *Annandale's Method* consists in excising a portion of the enlarged vein, as practised by Marshall and Steele in cases of varix of the extremities; hemorrhage may be arrested by acupressure as in Lee's operation. This mode of treatment has also been successfully employed by Mr. Howse. Rigaud simply exposes the vein without removing any portion of it.

FIG. 547.



Wood's instrument for varicocele.

These operations (of which Lee's seems to me upon the whole the best) are all attended with some risk, and can only be justifiable in exceptional cases.

SARCOCELE AND TUMORS OF THE TESTIS.

Sarcocele is a general term, commonly but rather unfortunately applied to all solid enlargements of the testicle. Surgeons speak of several varieties of sarcocele, as the *simple*, the *tuberculous* or *scrofulous*, the *syphilitic*, the *cystic*, and the *malignant*.

Simple Sarcocele is the chronic enlargement of the testis which results from inflammation of the organ. The affected gland is moderately increased in size, smooth and rather hard to the touch, though occasionally semi-fluctuating in parts, and somewhat painful and tender; the cord also is, in most cases, thickened and indurated. When cut into, the testis is found to be infiltrated with lymph in various stages of organization or fatty degeneration, the latter condition giving the appearance of yellowish spots which are often mistaken for tubercle. Suppuration occurs in some cases, and may be followed by hernia of the testis. Simple or inflammatory sarcocele is often accompanied with effusion into the tunica vaginalis, constituting *Hydrosarcocele.* The *treatment* consists in strapping the testicle, with the occasional application of a few leeches, and attention to the state of the general health; hernia of the testis is to be treated as described at page 991.

Tuberculous Sarcocele.—A deposit of true tubercle in the testis is, I believe, a less common affection than is ordinarily supposed, many of the cases which are called tuberculous sarcocele being really instances of simple enlargement from chronic inflammation, occurring in persons of scrofulous diathesis. True tubercle in the testis, according to Carswell, Curling, and Salleron, is first developed as an intra-tubular affection, but, according to Rindfleisch, Virchow, and other modern pathologists, originates primarily in the interstitial areolar tissue.

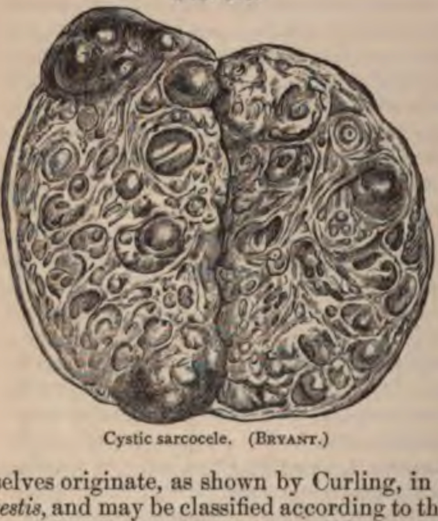
Causes.—The causes of tuberculous sarcocele are involved in some obscurity. It is ordinarily said to follow gonorrhœa or sexual excess, or to be due to some traumatic injury of the part; but, according to Salleron (who has published an elaborate memoir on the subject, based upon an analysis of 51 cases), the true tuberculous sarcocele never follows these affections, which are common causes of the simple sarcocele, except as a coincidence. His theory is that tubercle is deposited in the testis in infancy, as a manifestation of the tuberculous diathesis, but that the affection is not called into activity until after the period of puberty, when the generative organs become subject to functional excitement.

Symptoms.—Tuberculous sarcocele commonly begins in the epididymis, but ultimately involves the whole testis, forming a large, nodulated, and usually indolent mass. In some cases, however, the enlargement is uniform, smooth, and semi-elastic. In the nodulated variety of the disease, one or more of the nodules gradually inflame and become adherent to the skin, abscesses forming, and perhaps leading to the occurrence of fungous protrusions, or herniæ of the testis, and the greater part of the gland thus being, in some instances, gradually extruded from the scrotum. Both testicles are usually successively involved.

The vasa deferentia, vesiculæ seminales, and prostate, are often similarly affected, and the patient may present evidences of phthisis, or of scrofulous disease of the lymphatic glands or other organs. The affection may be complicated with hydrocele.

Treatment.—The treatment consists in attention to the state of the general health, in regulation of the diet, and in the administration of cod-liver oil, iron, iodine, etc. The patient should live as much as possible in the open air. The part should be supported in a well-fitting suspensory bandage, and advantage may be derived from the occasional application of iodine, or of local sedatives if there be much cutaneous inflammation. Humphry recommends that, in very bad cases, the sinuses should be laid open, the scrofulous matter turned out, and the parts stimulated to healthy action by the application of nitrate of silver. Verneuil recommends the actual cautery. Castration can be justifiable only when the general health is evidently suffering from the drain caused by the local affection.

FIG. 548.



Cystic sarcocele. (BRYANT.)

Syphilitic Sarcocele, in both of its varieties, has already been described (p. 460). The *treatment* is that of syphilis in general—mercury being particularly applicable in the early or "interstitial," and iodide of potassium in the late or "gummy," form of the disease.

Cystic Sarcocele.—This, which was called by Sir Astley Cooper the "Hydatid Testis," belongs to the *fibro-cystic* variety of tumor (see p. 483). The cysts themselves originate, as shown by Curling, in dilatations of the tubes of the *rete testis,* and may be classified according to the nature of their contents, as serous, sanguineous, or cutaneous proliferous cysts. The cystic sarcocele is often associated with *cartilaginous* growths, and sometimes with *sarcoma* or *cancer.*

Diagnosis.—Cystic sarcocele very seldom occurs in persons under twenty years of age, though F. H. Gross has met with it in an infant; it may commonly be distinguished from *hydrocele* (the affection with which it is most likely to be confounded) by observing its shape, which is globular rather than pyriform, and its want of translucency when examined with transmitted light. From *malignant sarcocele* it may be distinguished by its slower growth, and the absence of glandular implication and of cachexia. In some instances, however, the diagnosis can only be made by puncturing the growth with a trocar and canula—when, if the case be one of cystic sarcocele, a few drops of serous fluid will probably be evacuated by each puncture, from the successive opening of different cysts—or even by microscopical examination after removal.

Treatment.—This consists in castration, which may be performed as soon as the nature of the case has been ascertained.

Congenital Dermoid Cyst.—Another form of cystic disease of the testicle is the *congenital dermoid cyst*, which usually contains bone, teeth, or hair, and is believed by many writers to be an example of the malformation known as "fœtal inclusion." Cases of this affection, which is one of great rarity, have been recorded by several surgeons, among others by Prof. Van Buren, of New York. In the case observed by this distinguished surgeon, the patient, a child 2½ years old, had been treated (for what was supposed to be a hydrocele) by the establishment of a seton, which led to much suppuration and the protrusion of a large fungous mass. The *treatment* consists in castration, unless, as occasionally happens, the growth be entirely external to the testicle, when excision of the tumor alone would be sufficient.

Other Non-malignant Growths are occasionally found in the testicle, as the *fibrous*, *fibro-cellular*, *cartilaginous*, etc. The *diagnosis* from the simple and syphilitic forms of sarcocele, with which alone they are apt to be confounded, can be made by watching the effect of remedies, which, in the case of tumor, would of course be negative. The *treatment* consists in castration. *Fatty tumors* have been observed in the *spermatic cord*, from which situation they may be removed by excision.

Malignant Sarcocele, if *carcinomatous*, is almost always of the *encephaloid* variety, though both *scirrhous* and *melanotic* growths have been occasionally met with in this organ. Very many tumors of the testis, however, which would formerly have been classed under the head of encephaloid cancer, are by modern pathologists described as *sarcomata*. Another variety of malignant growth met with in the testis is the *lymphadenoma*, which has been particularly studied by Malassez, Monod, and Terrillon. It usually affects both testes, simultaneously or successively. In malignant sarcocele, the body of the testis is usually first involved, and the organ, when cut into, exhibits masses of a medullary character, in various stages of growth or degeneration, often mingled with cysts or cartilaginous nodules. The affection may occur at any age, but is most common in youth and early adult life.

The *symptoms* are the presence of a rapidly growing solid tumor—its growth is much more rapid than that of any other form of sarcocele—the mass being smooth, and at first uniformly firm to the touch, but afterwards soft, elastic, and semi-fluctuating in spots, with enlargement of the scrotal veins, and ultimately turgescence and thickening of the cord. The deep iliac and lumbar lymphatic glands are involved at an early stage of the disease, the inguinal glands not being affected until a later period. The tunics of the testis become very much distended by the enlarging tumor, and ultimately give way—when the growth becomes adherent to the scrotum; ulceration then follows, and allows the protrusion of a fungous mass. This stage of the disease is comparatively seldom seen at the present day, because the nature of the case is recognized, and castration resorted to, at an earlier period. The growth is attended with very little pain at any time, and the general health of the patient does not suffer in the early stage, though cachexia is ultimately developed. One testicle only is commonly affected.

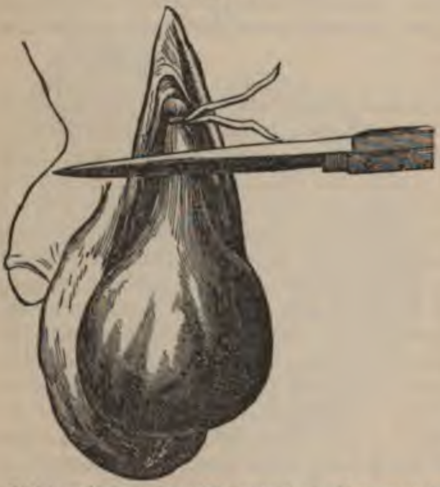
The *diagnosis* from other forms of sarcocele can usually be made by observing the very rapid growth of the tumor, its unilateral character, the enlargement of the scrotal veins, and the want of benefit from treatment; but the diagnosis from cystic sarcocele is often impossible until after removal, and even then without careful microscopical examination. From opaque hydrocele and from hæmatocele, malignant sarcocele may be distinguished by observing its weight and the sense of fluctuation which it affords in spots, and, if necessary, by an exploratory incision; this is better than puncture with a trocar, because, as pointed out by Humphry, the quantity of blood which flows through the canula from an encephaloid testicle may be so great as to lead to the supposition that the case is one of hæmatocele.

The *prognosis* is very unfavorable, death commonly taking place within two years, from the implication of the deep-seated glands, and from the occurrence of secondary deposits in the lungs and other viscera.

The only *treatment* which offers the slightest hope of benefit is castration, and this operation is, as a rule, justifiable only in the early stages of the affection, before the pelvic and lumbar glands have become involved—a point which can be determined by careful palpation of the abdomen.

Castration.—The operation of castration, or removal of a testicle, is thus performed: The part having been shaved, and the patient etherized, the surgeon grasps the posterior part of the tumor with his left hand, so as to make the scrotum tense in front; a longitudinal incision is now made from opposite the position of the external abdominal ring to near the bottom of the scrotum, which is then peeled off, as it were, by a few strokes of the knife, until the gland hangs merely by the spermatic cord. The division of the cord is the most important part of the operation; this may be conveniently done with the *écraseur*, but may be equally well accomplished with the knife—bleeding in the latter case being prevented by previously ligating or acupressing the cord *en masse;* or the cord may be firmly held by an assistant, and its arteries tied separately after division. The precise point at which the cord is divided is of no consequence in the excision of non-malignant growths, and hence the surgeon may, if it be found more convenient, secure the cord before completing the dissection of the tumor. In castra-

FIG. 549.



Division of spermatic cord in castration. (ERICHSEN.)

tion for malignant disease, however, it is important to cut the cord at as high a point as possible, and in these cases it is therefore better to dissect out the testicle, and carry the dissection up to the abdominal ring—then transfixing the cord with a double ligature, tying it in two halves, and dividing it a little lower down, in the way already described. It is sometimes recommended that an elliptical portion of the scrotum should be removed, if the tumor be large; but the skin of this part shrinks so much after the operation that such a course can rarely be necessary. The after-treatment consists in simply bringing the edges of the wound together, with or without stitches, as may be preferred, and in applying cold water dressing.

FUNCTIONAL DISORDERS OF THE MALE GENERATIVE APPARATUS.

Impotence may result from several different conditions, of which some are, while others are not, remediable.

1. *Malformation or Mutilation of the Genital Organs* may cause impotence, occasionally curable by operation (see page 981), but more commonly irremediable.

2. *Debility of the Nervous Centres,* following severe illnesses, or attendant upon diseases in which the general nutrition is impaired, may render the patient temporarily or permanently impotent. The *treatment* consists in the adoption of means to improve the general health, the exhibition of tonics, such as iron, quinia, strychnia, and phosphorus, sea-bathing, etc.

3. *Traumatic or other Lesions of the Cerebro-Spinal Nervous System.*—Impotence from this cause is commonly permanent; the *treatment* would be that of the particular affection to which the impotence was due.

4. Temporary, or rather imaginary, impotence may arise from *Mental Perturbation or Over-excitement.* This condition is chiefly met with in first attempts at coitus, whether sanctioned or not by the matrimonial tie. The affection is, I believe, never permanent.

5. *Morbid Excitability of the Genital Organs,* attended with involuntary seminal emissions (*spermatorrhœa*), occasionally gives rise to impotence, and is a very intractable affection, simply because it is often impossible to prevent the continued activity of the causes to which it is originally due. The commonest cause of this condition is probably onanism; though it may also arise from premature or excessive indulgence in venery—and is kept up by impure habits of thought or conversation, reading obscene books, or gloating over lascivious pictures—while in its milder forms it may originate from irritation of neighboring organs, as the bladder or rectum.

Seminal Emissions are by no means necessarily a sign of disease; indeed, during early manhood, an occasional discharge of spermatic fluid during sleep, is an almost unavoidable attendant upon virtuous celibacy; but when the emissions occur in the day as well at night, and are very frequently repeated, they certainly indicate an unnatural state of debility and irritability of the sexual apparatus. In the worst cases the patient is rendered impotent, by the emission taking place without any or with such slight erection that penetration is impossible.

Spermatorrhœa, as this affection is called—rather unfortunately, for the seminal flux is a mere symptom—is chiefly met with between the periods of puberty and early adult life, and is most common in young men of feeble frame and of sedentary habits. In advanced stages the patient's general health suffers, and he often falls into a state of great mental depression. At the same time, there can be no doubt that, in many cases, ill health and various nervous affections, such as epilepsy or insanity, are attributed without sufficient reason to morbid excitability of the genital organs and to onanism—when in point of fact the supposed causes are really the effects; physical debility often exists where the sexual appetite is fully if not inordinately developed, and an excitable disposition, or an ill-balanced mind, renders its possessor less able to resist temptation, and more apt to fall into habits at which the moral sense revolts, than he who is blessed with both a healthy body and a healthy mind. The frightful pictures drawn by Tissot, Alibert, and other writers, are no doubt strictly correct; but the unfortunate victims whose histories they narrate were not insane from onanism—they were onanists because they were insane.

The *diagnosis* of spermatorrhœa from *chronic prostatitis* (*prostatorrhœa*) is readily made by microscopic examination of the discharge (see page 937).

The *treatment*, as far as the use of remedies is concerned, consists in diminishing the irritability of the genital organs, and in improving the general condition of the patient. The food should be abundant, but wholesome, and particular care should be taken not to overload the stomach at night; alcoholic stimulants and spices should, as a rule, be avoided. The patient should take plenty of exercise in the open air, walking being better than riding or driving, as the motion of the horse or carriage sometimes excites the venereal orgasm; he should sleep on a hard mattress—lying on either side rather than on the back—and should not be too warmly covered. Tonics, especially iron, quinia, strychnia, phosphorus, and occasionally cantharides, may be administered with advantage, while cold hip-baths, the cold douche or shower-bath, and sea-bathing (if this can be procured) will also prove of service. Bromide of potassium may be given in a full dose at bedtime, and will often procure sound rest, undisturbed by seminal emissions; the hydrate of chloral has been recently recommended for the same purpose, as has the monobromide of camphor, by Dr. J. L. Vogel. Nowatschek speaks favorably of hypodermic injections of atropia. The application of nitrate of silver in substance or solution (gr. xx–xl to f℥j) to the prostatic and bulbous portions of the urethra, may be of service in cases in which these parts are found by external pressure to be morbidly sensitive; the application may be made with a porte-caustique or syringe-catheter (as in cases of chronic prostatitis), and may be repeated at intervals of ten days or two weeks. Cold, applied as recommended by Winternitz (p. 937), may be of use in some cases.

The course of treatment above described is addressed to the morbidly irritable condition of the genital organs, and may be employed with every prospect of success, provided that the causes of that condition have ceased to act, or can be removed. In cases originating in irritation of neighboring parts—as from hemorrhoids, from the presence of ascarides, or from an abnormal condition of the urine—this can be readily done; but when the unnatural irritability of the generative apparatus is kept up by constant excitation of the part, whether physical or mental, the prognosis is less favorable, because the removal of the cause is more difficult. Chastity in thought as well as deed is necessary to insure recovery; but to attain this grace requires a prolonged struggle with temptation, which needs all the patient's fortitude and resolution. The treatment in these cases must be more moral than physical, and even when a purely physical cause, such as onanism, is to be dealt with, surgery offers remedies of but doubtful efficacy; the application of blisters to the penis, or the operation of circumcision, may be of use in compelling at least a suspension of a bad habit; but the benefit will be evanescent, unless the moral nature of the patient can be reached in the interval. In their despair at continual relapses, victims of onanism have, it is said, occasionally made Abelards of themselves, with the hope that they would thus effectually banish temptation; and surgeons, even, have been induced to castrate their patients, in obedience to the earnest solicitations of the latter. The operation has, however, in the large majority of cases, proved as unsuccessful as it is unphilosophical; there is no reason to believe that the testes are particularly at fault, and the disease is in all cases more of the mind than of the body; moreover, the gain to the moral nature of the individual is not in cowardly fleeing from, but in manfully resisting, temptation. The benefit which has been apparently derived, in some instances, from this heroic mode of treatment, has been, in all probability, such merely as might have been obtained from any great and sudden shock to the nervous system.

The surgeon is occasionally called upon for an opinion as to whether an individual, who has suffered from frequent seminal emissions, and who, perhaps, fears that he is in consequence impotent, may properly enter into matrimonial engagements. The question is rather a delicate one, and no rule can, of course, be given which would be of universal application; but it may probably be safely said that, though, if undertaken merely with the selfish hope of effecting a cure for himself, without regard for the happiness of his partner, marriage will, in all probability, disappoint the man's expectations, yet the happy circumstances of a union founded on mutual preference and pure affection will offer the very best prospects of recovery.

Sterility in the male may exist in connection with impotence, or independently. It most frequently arises from some local source of obstruction to the passage of the spermatozoa—as from induration and thickening of the globus minor as the result of epididymitis, or from urethral stricture—but may also depend upon retention of the testes within the abdominal cavity, upon absence of spermatozoa from the semen, or upon obscure changes in the chemical constitution of that fluid, the nature of which is not very well understood. The only hope of cure would be in the removal of any disease of the genito-urinary apparatus which might be detected.

DISEASES OF THE FEMALE GENITALS.

The limits of this volume will merely admit of a brief reference to those diseases of the Female Generative Apparatus which require *operative, or distinctively surgical* treatment; nor is a more extended account of these affections here necessary, for the whole subject properly belongs to the domain of Gynæcology, and is ably discussed in the numerous valuable works on Diseases of Women which are now accessible to the student.

Malformations.

The external genitals are subject to various malformations of very different degrees of severity.

Imperforate Vulva.—This, which is the slightest form of imperforate vagina, consists in a congenital occlusion of the vagina at or just in front of the nymphæ. The septum is at first very delicate, and, if the condition is recognized soon after birth, can be readily ruptured by simply separating the parts with the thumbs, one placed upon each of the labia majora, or may be torn across with a probe or director, a strip of oiled lint being interposed to prevent reunion. At a later period a little dissection with the scalpel may be required, but the affection is always readily amenable to treatment.

Adhesion of the Vulva is a condition precisely similar to the above, except that it is not congenital, but arises from adhesion of the opposing surfaces of mucous membrane, as the result of inflammatory action. The *treatment* consists in dissecting through the obstruction, and preventing its recurrence by the introduction of a tent.

Imperforate Hymen.—The hymen may be *partially perforate*, or *completely imperforate*.

1. *Partially perforate hymen* allows the escape of the menstrual fluid, but interferes with sexual intercourse—the thickness and rigidity of the membrane preventing penetration. In some instances pregnancy has occurred in spite of this obstacle, and the condition of parts has been first recognized from the effect of the dense hymen in hindering parturition, by arresting the passage of the fœtal head. The *treatment* of partially perforate hymen consists simply in incising the part with a probe-pointed bistoury, dilatation being completed by means of a sponge-tent or bougie.

2. *Imperforate hymen* is a much more serious condition. If it were recognized before the age of puberty, it could be readily remedied by making a crucial incision, and by excising the flaps which would thus be formed; but, unfortunately, the malformation is seldom discovered until menstruation has repeatedly occurred, and until the vagina and uterus have become distended, sometimes to a great extent, by the accumulating secretion—forming a large, elastic, fluctuating tumor in the hypogastrium. The operation for the relief of this condition is easily and quickly performed, but is not unfrequently followed by serious and even fatal consequences. Death may result from endometritis and septicæmia, due to decomposition of the uterine contents; or from peritonitis, due to the escape of blood through a laceration of the Fallopian tubes, or even through their natural orifices, into the abdominal cavity. To prevent these accidents, it is recommended by Bernutz and Goupil that the hymen should be punctured with a small trocar and canula, a piece of tubing being attached to the latter, so that the contents of the uterus shall slowly drain away. The puncture should be made eight or ten days after a menstrual period, and no pressure should be made upon the abdomen during the process of evacuation.

Imperforate Vagina.—This may vary in degree from the slight affection already referred to as imperforate vulva, up to complete absence of the vagina, accompanied, perhaps, with absence or imperfect development of the uterus. By simultaneous exploration with a sound in the bladder and a finger in the rectum, the thickness of tissue between those parts can be estimated, and, if it be such as to render the existence of the uterus and upper part of the vagina tolerably certain, an effort may be properly made to reach the upper part of the tube during early childhood, when operations on these organs are less dangerous than in adult life. If, however, the bladder and rectum be in such close contact as to render the existence of a uterus doubtful, it will be proper to wait until the period of puberty, when the nature of the case will probably become more evident. In many instances the existence of malformation is not suspected until after puberty, when the attention of the patient and of her friends is aroused by the non-appearance of the menses, although the menstrual molimen may recur at regular intervals.

The *treatment* to be pursued under such circumstances is a matter worthy of the gravest consideration. Any operation in such a case will be attended with considerable risk, and yet if the womb is becoming every month more and more distended with menstrual fluid, an operation is absolutely necessary—for while unrelieved the patient is in constant danger of peritonitis (from leakage backwards through the Fallopian tubes), or even of rupture of the uterus. The treatment of imperforate vagina varies according to the condition of the uterus.

(1.) If the presence of an *elastic fluctuating tumor* in the region of the uterus, perceptible by rectal exploration and by abdominal palpation, shows that there is an accumulation of menstrual fluid in the womb, there can be no question as to the propriety of an operation. It has been proposed to evacuate the uterine contents by puncture with a trocar and canula through the rectum, but, beside the risk of wounding the peritoneum in such an operation, the relief would probably be but temporary, and re-accumulation would occur. Hence, it is better in such a case to attempt the formation of a vagina, by placing the patient in the lithotomy position, and, after making a small transverse incision, working cautiously upwards with the finger and handle of the knife in the septum between the bowel and urethra (taking care not to open either of these), and guiding the dissection by keeping a sound in the bladder, and a finger in the rectum. When the sac containing the menstrual fluid is reached, it should be opened through a speculum with a small trocar, with the same precautions as in the case of imperforate hymen. The size of the newly-formed vagina must be subsequently maintained by the use of a bougie. In Amussat's method, which is preferred in these cases by Bernutz and Goupil, the knife is dispensed with altogether, and the vagina formed by simply stretching the vulvar mucous membrane and pushing apart the rectum and urethra with the fingers; the operation occupies several days, dilatation being maintained in the intervals between the sittings by the introduction of tents. Le Fort has reported a remarkable case, in which he formed a vagina by passing a weak galvanic current through the parts every night for a month; the negative pole was applied to the seat of occlusion and the positive pole to the wall of the abdomen, and the current used was at no time so strong as to inconvenience the patient.

(2.) If there be *no uterine tumor*, the course to be pursued is more doubtful. The menstrual molimen, it must be remembered, depends upon the ovaries, and not upon the uterus; and a patient may suffer intensely at every monthly period, while having no womb, or at least none capable of menstruating, and therefore no menstrual accumulation. If in a case of this kind it be ascertained by careful rectal exploration, conjoined with abdominal palpation, that there is a well-formed womb—even though not distended—an operation such as was described in the last section might be justifiable, though full of danger from the risk of opening the peritoneal cavity. If, however, it be found that there is no womb, or merely a rudimentary uterus (as in a case under my care at the Episcopal Hospital), no operation whatever should be performed. A good deal is sometimes said in these cases about fitting a young woman for matrimony, enabling her to be a wife, etc.—but, in point of fact, a woman to whom nature has denied a womb can never be adapted for marriage, though she may be fitted for prostitution. The surgeon's art may, indeed, enable her to be a man's mistress, but can never fit her to be his wife and the mother of his children. Prof. Gross speaks none too strongly when he says that, in such cases, "nothing is to be done . . . ; the woman is impotent, and therefore disqualified for marriage."

Non-Congenital Obliteration of the Vagina results from adhesion of the vaginal walls after sloughing or severe inflammation; it is most common in married women after labor, but may occur in young girls or children. The *diagnosis* from congenital absence of the vagina can be readily made by simultaneous rectal and vesical exploration, which will, in a case of non-congenital obliteration, reveal the existence of a dense septum, three-quarters of an inch or more in thickness—whereas, in a case of imperforate vagina, the instrument in the bladder and the finger in the rectum seem almost to be in apposition, and are evidently separated by a very thin layer of tissue. The *treatment* of the affection now under consideration consists in endeavoring to re-establish the canal, by cautious dissection between the urethra and rectum in the way already mentioned. The operation is attended with a great deal of danger, but is the only resource—and becomes imperatively necessary when the uterus is distended by the menstrual accumulation.

Double Vagina.—In many cases this condition requires no treatment, and may be looked upon as merely a physiological curiosity. Should, however, it become necessary to divide the vaginal septum, this may be readily done with blunt-pointed scissors, adhesion of the cut surfaces being prevented by the introduction of a strip of oiled lint, and cleanliness secured by the frequent use of detergent injections.

SURGICAL DISEASES OF THE VULVA.

Hypertrophy of the Labia Majora is usually an inflammatory condition, depending, as in the case of the lips, upon the presence of a fissure or excoriation, and slowly disappearing when that is healed.

Hypertrophy of the Labia Minora is occasionally met with, resembling anatomically what has been described as the "fibro-cellular out-growth." In warm climates this condition is comparatively common, and in some localities is said to be almost universal. The *treatment*, when the hypertrophy increases so much as to produce annoyance, consists in excision; this operation is sometimes attended with a good deal of hemorrhage, which may be conveniently arrested, as advised by Hutchinson, by transfixing the base of the labium with harelip pins and applying figure of 8 ligatures, so as to acupress the pedicle, as it were, *en masse.*

Hypertrophy of the Clitoris is usually, I believe, the result of constitutional syphilis. The organ sometimes attains a very large size, and produces a great deal of irritation, requiring excision, which may be performed either with the knife or with the *écraseur*. The bleeding in this operation may be quite profuse, and may possibly require the application of the actual cautery.

Excision of the Clitoris, or Clitoridectomy, has been most unphilosophically proposed and practised as a remedy in cases of epilepsy and insanity. The operation has been forcibly and properly condemned by the almost unanimous voice of the profession.

Vegetations, the so-called *venereal warts*, are often seen upon the vulva, and require extirpation with the knife or scissors.

Tumors of various kinds are met with in the labia, the most common being the cystic tumor, though fatty, fibrous, and vascular growths are also met with in this situation. Two kinds of *cyst* are met with in the neighborhood of the labium; one consists in a dilatation of Cowper's gland, and is curable by making a simple incision, and stuffing the cavity with lint, while the other is a serous cyst, which is developed in the labium itself, and sometimes attains a very large size. The *treatment* of the latter consists in excision, the operation requiring a rather troublesome dissection, and being attended with a good deal of bleeding, which can, however, always be checked by pressure and the use of a T bandage. *Fibrous* and *fatty* tumors of the labium also require excision, while *nævi* in this part may be conveniently treated by ligation.

Hydrocele of the Canal of Nuck is a rare affection, which was referred to in speaking of pudendal hernia (page 829). The *treatment* consists in the formation of a seton, or in the injection of iodine.

Malignant Disease of the External Genitals may be primary—in which case it is usually *epitheliomatous*—or secondary to cancer of the vagina or uterus, either of the *scirrhous* or *encephaloid* variety. The vulva is also, sometimes, the seat of *rodent ulcer*. The sole *treatment* for any of these affections is excision, which is, however, only justifiable when the disease is so limited as to admit of complete extirpation.

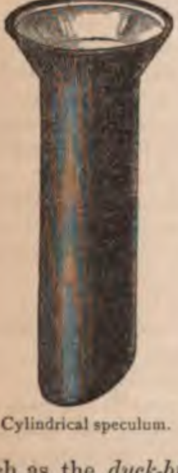
Vulvitis, in whatever way arising, presents the same symptoms, and demands the same treatment, as when of gonorrhœal origin. (See page 438.)

Noma Pudendi has already been referred to at page 401.

SURGICAL DISEASES OF THE VAGINA.

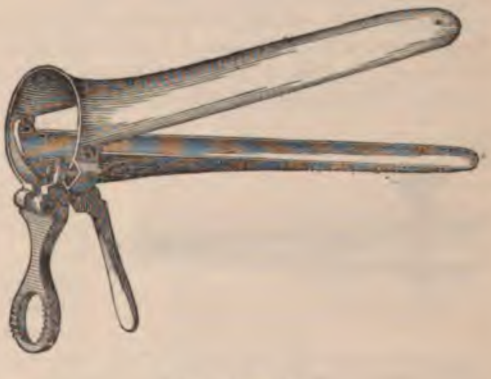
The Speculum is an instrument constantly required for exploration of the upper part of the vagina and the cervix uteri. For ordinary purposes, the best instruments are the simple *cylindrical* speculum made of glass, coated like a mirror with quicksilver or tinfoil, and covered with India-rubber (Fig. 550), and the *bivalve* speculum, of which the best form is that known as Cusco's (Fig. 551). For special cases, other instruments may be required, such as the *duck-billed speculum* (Fig. 531), either in its original form, or with the ingenious modifications of Emmet, Pallen, Thomas, Fryer, and others; Thomas's *telescopic speculum;* Ellis's *expanding speculum;* or the somewhat similar ingenious contrivances of Dr. Albert H. Smith and Dr. J. S. Hough, of this city. Barnes highly commends Neugebauer's speculum,

FIG. 550.



Cylindrical speculum.

FIG. 551.



Cusco's speculum.

which combines the features of both the bivalve and the duck-billed instruments.

The speculum should always be introduced (well warmed and oiled) under cover of the patient's garments or bedclothes, without any exposure of the person. For ordinary examinations, the obstetric position on the left side will be satisfactory, but for the application of caustics, removal of polypi, etc., it will usually be more convenient to place the patient on her back, with the lower limbs separated and supported upon chairs. The introduction of the speculum may be conveniently effected by separating the vaginal walls with the fore and middle fingers of the left hand, and slipping in the instrument beneath and between them.

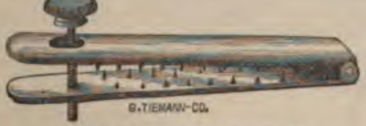
Painful Ulcer or Fissure of the Vagina.—This affection is closely analogous to the painful ulcer of the rectum or anus, and requires precisely similar treatment. (See page 851.)

Polypoid Growths, belonging to the class of fibro-cellular tumors, are occasionally met with in the vagina, and may be treated by avulsion (if the pedicle is very small), ligation, the *écraseur*, or the wire loop and galvanic cautery.

Cystic and other Tumors in the walls of the vagina are to be treated as similar affections of the vulva. *Cancer* of the vagina seldom admits of operative interference.

Prolapsus of either the front or back wall of the vagina, may take place, constituting, in the former case, a variety of hernia of the bladder or urethra (*cystocele, urethrocele*), and, in the latter case, a similar condition of the rectum (*rectocele*). In most instances, sufficient relief may be afforded by the use of a suitable pessary or bandage, but occasionally a more radical measure may be required; this may, in a case of cystocele or rectocele, consist in denuding a circular strip of the vagina near its orifice, and bringing the sides together with sutures, so as to obtain adhesion of the labia majora for the lower three-fourths of their extent; or, if the case be complicated with prolapsus of the uterus, in denuding a longitudinal strip on either side of the vagina (or, which is better, a broad triangular space on the posterior wall of the canal), and then bringing the raw surfaces together, so as to reduce the calibre of the vagina through its entire length. The former operation is known as *Episiorrhaphy*, and the latter as *Elytrorrhaphy*. *Episiorrhaphy* has been modified by J. Bell by *splitting* instead of *paring* the labia, as in Langenbeck's and Collis's operations for vesico-vaginal fistula. Thomas has modified the operation of *elytrorrhaphy* by separating the layers of the vaginal wall by a subcutaneous, or rather submucous, procedure, then clamping the separated tissue with the instrument shown in Fig. 552, and cutting off the part which protrudes. Schroeder and B. F. Dawson treat cystocele by denuding the *anterior* wall of the vagina and bringing the parts together with sutures, the latter surgeon folding the vesical wall upon itself by pressure with a sound, so as to bring the sides of the raw surface into close apposition. The treatment of *urethrocele* has already been referred to at page 952.

FIG. 552.



Thomas's clamp for elytrorrhaphy.

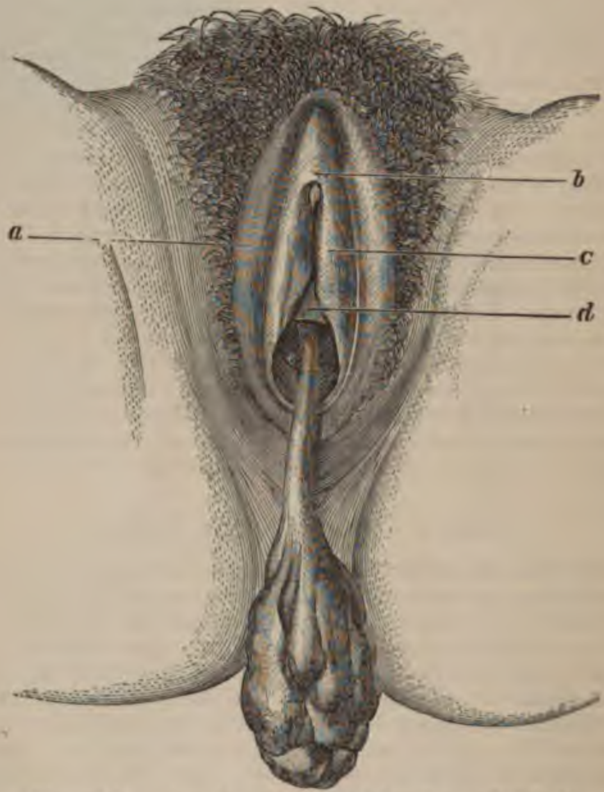
Vaginismus is the name given by Sims to an affection which consists in a hyperæsthetic condition of the nerves distributed to the vaginal mucous membrane at the position of the hymen, leading to a spasmodic contraction of the sphincter vaginæ muscle, which renders coitus intensely painful, and, indeed, usually impossible, and thus practically makes the patient sterile. The spasm of the sphincter may be elicited by the slightest touch of the finger, or even of a camel's-hair brush. Vaginismus may be an idiopathic affection occurring in persons of a hysterical temperament, or may be due to some local cause, such as fissure of the vagina or rectum, papillary tumor of the meatus, inflammation of the womb or vagina, eczema or prurigo of the vulva, neuralgic tumors, etc. The *treatment* consists in removing the cause, if this can be ascertained, and in the administration of tonics, and the use of sedatives, iodoform being specially recommended by Tarnier. Attempts may be made to relieve the spasm by the use of vaginal dilators, or, if necessary, by a resort to operative treatment. The simplest operation for vaginismus consists in sudden dilatation or partial rupture of the sphincter vaginæ muscle, effected by introducing the thumbs and forcibly separating them (the patient being etherized), as in Récamier's and Van Buren's method of treating fissure of the anus. If this fail, the remains of the hymen may be excised, and the sphincter partially divided by a deep incision on either side of the perineal raphe (as recommended by Sims), or the pudic nerve may be cut—by direct incision, as originally recommended by Burns—or subcutaneously, as preferred by Simpson. These operations sometimes afford only temporary relief, and the constitutional treatment appropriate to neuralgia must therefore not be neglected after their employment.

SURGICAL DISEASES OF THE UTERUS.

Fibrous or Fibro-Muscular Tumors (*Uterine Fibroids, Myomata*).—These, which are the most common of the uterine tumors, may occupy any portion of the structure of the womb. They may project on the outer surface of the organ beneath its peritoneal investment; may grow inwards, filling the uterine cavity, and perhaps descending through the vagina and protruding between the labia; or may be developed in the midst of the uterine wall. They are classified according to their situation into subserous or sub-peritoneal; submucous; and interstitial or intermural fibroids. They are but loosely attached to the surrounding tissues, and sometimes attain a very large size. In the majority of cases *palliative treatment* only is required; and it must always be remembered that uterine fibroids seem to disappear spontaneously in some instances; or may become detached, and may be expelled by the contractions of the womb. The most promising mode of treatment is, I think, the hypodermic use of ergot or ergotin, as recommended by Hildebrandt, Scanzoni, and Keating, of this city; my own experience with this remedy, though limited, confirms, as far as it goes, the favorable reports of those gentlemen. The following formula will be found satisfactory: ℞. Ext. ergot. fluid. fʒiss; Glycerinæ, fʒj; Aquæ, fʒij. M. Twenty minims to be injected once daily in the hypogastric region.

In cases of *submucous* fibroids, *excision* or *avulsion* may be practised, a convenient instrument for the purpose being the "serrated scoop" or "spoon-saw," devised by Thomas; but if the growth be attached by a somewhat narrow pedicle (constituting the *fibrous polypus* of the uterus), it will usually be better to remove the tumor by means of the *écraseur*, for the chain of which a wire rope may be substituted, as recommended by Braxton Hicks, or a steel wire, as preferred by Kidd, of Dublin. The *écraseur* may be applied by the aid of the ingenious "*porte-chaine*" of Dr. Marion Sims; or the simpler form of instrument devised by Dr. Emmet, may be substituted; or a ligature may be first thrown around the pedicle with a double canula, and the chain of the *écraseur* subsequently drawn into place. The operation may be facilitated by seizing the part to be removed with shouldered tenacula which may then be fixed in a handle, as suggested by Dr. A. H. Smith, of this city.

FIG. 553.



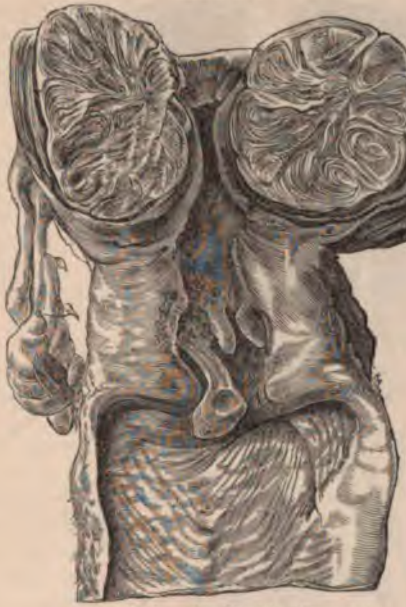
Fibro-cellular uterine polypus with long pedicle. (BOIVIN and DUGÈS.)

In the case of *interstitial* growths, *enucleation* has been resorted to by Amussat, Atlee, Fordyce Barker, Thomas, and others. The operation consists in dilating or incising the cervix uteri, laying bare the tumor by cutting through its capsule, and then turning it out of its bed with the fingers, Thomas's "spoon-saw," or other suitable instrument. This procedure has not unfrequently proved fatal, from hemorrhage, peritonitis, or pyæmia, and, though doubtless justifiable in exceptional cases, cannot, in my judgment, be recommended as a general mode of treatment. A similar opinion is expressed by Pozzi, who has collected 64 cases of this operation, 16 of which terminated fatally.

Mr. I. Baker Brown has modified this operation by simply incising the tumor, or even the mouth and neck of the uterus, so as to destroy the vitality of the growth, and promote its expulsion by sloughing. According to Braxton Hicks, an intermural fibroid may sometimes be converted into a polypus by the administration of ergot. Emmet advises frequent traction upon the tumor with tenacula or forceps, so as to excite contraction in the uterus, and thus promote enucleation and guard against hemorrhage.

Subserous uterine fibroids have, in a number of instances, been removed by abdominal section, the operation sometimes involving the extirpation of the entire uterus and both ovaries (see page 872). This mode of treatment under any circumstances is replete with danger, and can only be justifiable in exceptional cases. The statistics of the procedure have been investigated by several writers, the most recent being Pozzi, who finds that 119 cases, including those collected by Routh, Koeberle, Caternault, and Péan and Urdy, gave 77 deaths, a mortality of nearly 65 per cent. Dr. Sutton has removed a subserous fibroid through an incision in the posterior wall of the vagina, but the patient died in six hours. Drs. Kimball and Cutter have met with some success from the use of galvano-puncture in these cases.

FIG. 554.

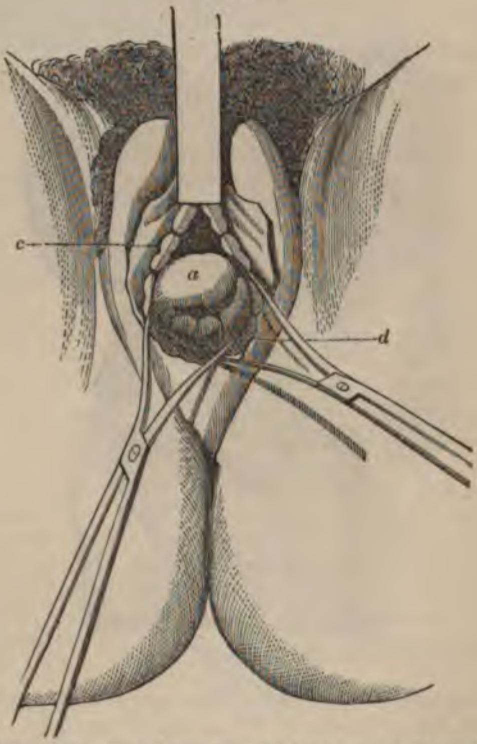


Interstitial uterine fibroid. (BARNES.)

Fibro-cystic Tumors of the Uterus have been particularly studied in this country by C. C. Lee, Atlee, Peaslee, and Thomas. They have often been mistaken for ovarian cysts (see page 865). Only palliative treatment is as a rule to be recommended.

Polypi of the Uterus usually belong to the *fibro-cellular* or *myxomatous* varieties of tumor, and are often very vascular, and accompanied with an increased development of the glandular structures of the part. The *hard* or *fibrous polypus*, a variety of the uterine fibroid, has already been referred to. Polypi are usually attended by more or less profuse hemorrhage, which exhausts the patient and urgently demands surgical interference. The *treatment* consists in effecting the extrusion of the polypus from the uterus by drawing it down with forceps, or, if this cannot be done, by dilating or incising the neck of the womb and administering ergot, and in then dealing with the growth by excision, avulsion, ligation, or the use of the *écraseur*, in the way already mentioned (page 1011). Dr. McClintock, of Dublin, recommends the employment of a *hemp saw;* a loop of twisted cord is made to surround the base of the polypus, by aid of a double canula, the latter being then held by an assistant while the growth is cut through by drawing the cord backwards and forwards as in using an ordinary chain saw. It may be occasionally necessary to attack the polypus while still within the uterus, but the operation is under such circumstances attended with great danger.

FIG. 555.



Amputation of the neck of the uterus by means of the *écraseur*. *a*. Shows the neck of the organ dragged to the vulva by means of forceps. *c*, *d*. The chain of the instrument passed around the part at its base. (CHASSAIGNAC.)

Myeloid and Recurrent Fibroid Tumors (*Sarcomata*) have been occasionally observed in the uterus; the treatment would consist in excision, if the growth could be entirely extirpated without too much risk to the patient.

Malignant Tumors of the Uterus may be either cancerous or epitheliomatous. *Cancer of the uterus* is usually of the *encephaloid* variety, though *scirrhous* and *colloid* growths are also met with in this organ; the *treatment* should, in a very large majority of cases, be merely palliative, total extirpation being almost impossible, and partial excision, unless in very exceptional instances, being worse than useless. *Epithelioma* commonly attacks the os and cervix uteri, and may appear in one of two forms, viz., as the so-called "corroding ulcer," or as the "cauliflower excrescence." The *treatment* consists in amputation of the neck of the uterus, if the affection be recognized sufficiently early to allow of complete removal, or if not seen until a later period, in cauterization of the surface of the growth with caustics or the hot iron, or in extirpation of as much as can be reached by means of the *écraseur* or *curette*, a palliative measure which has been employed with advantage by A. R. Simpson, Simon, Munde, Parry, Goodell, and others. Sims carries the exsection quite up to the inner os.

Procidentia or Extreme Prolapsus of the Uterus may occasionally demand operative treatment; this consists in first amputating the neck of the organ (if it be much enlarged), and then performing an *episiorrhaphy* or *elytrorrhaphy* (p. 1010), or a *transverse obliteration of the vagina* (p. 979). This mode of treatment has been adopted in several cases by Prof. Goodell, of this city, with most gratifying results. *Kolpoperineoplasty* is another operation for the same purpose, devised by Bischoff; it consists in dissecting up a tongue-shaped flap of mucous membrane from the posterior wall of the vagina, and denuding a triangular space on either side; the edges of the flap are then stitched to the anterior edges of the denuded spaces, and the wound closed below with deep sutures, as in the operation for ruptured perineum. Pallen, of New York, substitutes for amputation of the cervix an operation which he calls *vagino-cerviplasty*. This consists in denuding the cervix circularly, dissecting the mucous membrane upwards from the junction of the body and neck of the womb, pushing the neck up into the sheath thus formed, and finally closing the wound with silk sutures.

Amputation of the Cervix Uteri may be performed by the aid of cutting instruments, by means of the *écraseur* (Fig. 555), or by the use of the wire loop and galvanic cautery. When the first method is resorted to, the part to be removed should be fully exposed by means of a duck-billed speculum; the neck of the womb is then slit up on either side, and its lips successively excised with suitable scissors, the uterine mucous membrane being finally drawn forward (as advised by Sims), and attached to that of the vagina by means of silver sutures. Dr. C. F. Clark, of Brooklyn, employs toothed scissors, dispensing with the preliminary slitting of the part, and leaving the stump to heal by granulation.

The subjects of *Lacerations of the Female Perineum, Vaginal Fistulæ, Ovarian Tumors*, and *Diseases of the Mammary Gland*, have already been referred to in previous portions of the volume.

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